THE GEOGRAPHICAL REVIEW

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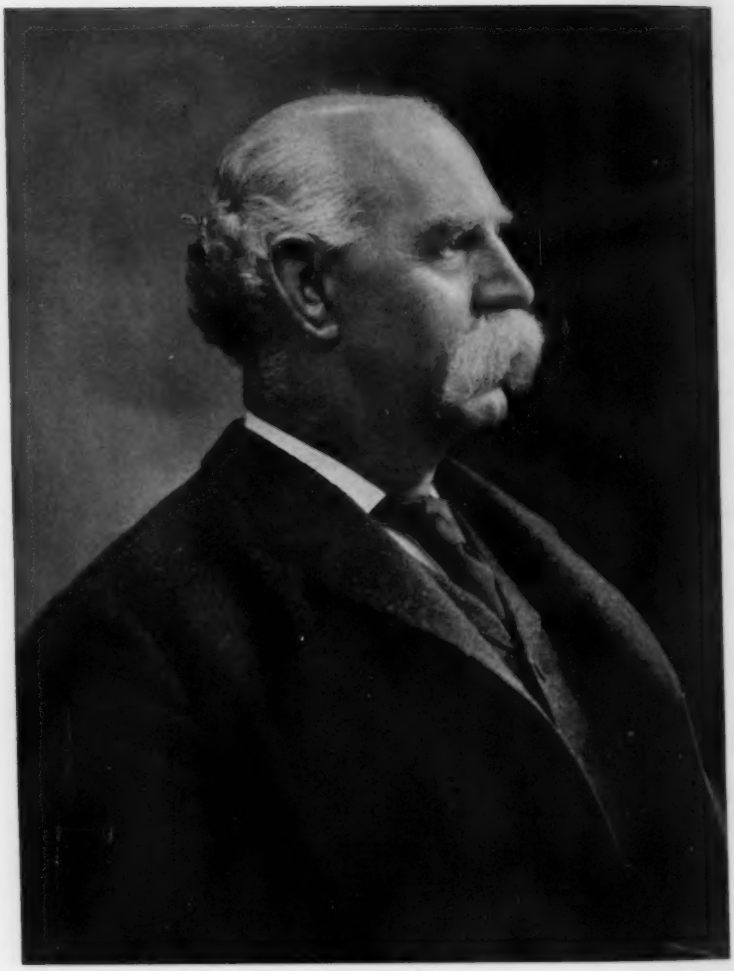
The Leardo Map of the World of 1452 or 1453. Colored reproduction (measuring 28⅝ x 23½ inches, printed on sheet 35 x 30 inches) of map in the collections of the American Geographical Society. Accompanied by volume containing text by JOHN KIRTLAND WRIGHT describing the original map and a note by A. B. HOEN on the method of reproduction, with 3 photographs and 7 maps. viii and 90 pp. *Library Series No. 4*. 1927. $15.00 ($2.00 for text alone).

Atlas of the Historical Geography of the United States. By C. O. PAULLIN. With 166 plates comprising over 620 separate maps. xiv and 145 pages; text; index. Published jointly by the American Geographical Society and the Carnegie Institution of Washington and distributed by the Society. 1932. $15.00.

Separate Maps published in the *Geographical Review* and the *Bulletin of the American Geographical Society*, the majority in color. 25 cents each. A list will be sent upon request.



JOHN GREENOUGH

March 25, 1846 – May 4, 1934

THE GEOGRAPHICAL REVIEW

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JOHN GREENOUGH

1846–1934

FOR many years the Society has enjoyed the association and benefited from the counsel of our Honorary President, John Greenough, whose death occurred on May 4. On February 25 last President Greenough had reached his eighty-eighth birthday. He had been a member of the Society since 1883, a Councilor since 1900, Chairman of the Council from 1913 to 1921, President from 1916 to 1925, and thereafter Honorary President. Few men in the history of the Society have filled so many of its offices, and none surpassed him in faithfulness to duty. He gave both of his time and of his means and had the gift of working in helpful association with his colleagues in the Council. During the long period in which he presided at the monthly meetings of the Society President Greenough was absent on only one occasion. Of striking and dignified appearance, he was an ideal presiding officer at public meetings.

A major development of the Society's work to which President Greenough brought both initiative and support was the adoption of the principle that as a scientific rather than a popular institution the first requirement of the Society was professional direction. To that end it was arranged that responsibility for the formulation of both policy and plans should be placed in the hands of a geographer, with later consideration and decision by the Council. The first director of the Society was appointed in 1915 on President Greenough's recommendation. Directly thereafter, as plans for fieldwork, research, and publication were advanced, President Greenough, who was both critical and wise in dealing with institutional matters, supported the new program wholeheartedly. While he was familiar with the details of the Society's scientific enterprises, he believed in administration by principle and never allowed himself to be drawn into a decision upon technical details. Endowed with good judgment, he was a resourceful adviser. Paraphrasing Mark Twain, he was fond of saying, "When required to handle a difficult situation limit yourself in the first instance

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to a simple enquiry." He had an inexhaustible supply of quotations, verses, sayings, and reminiscences that he drew upon as he dealt informally with the problems before him. While he had great force and dignity, he had also a sense of humor. It was one of his fixed principles, tellingly illustrated on occasion, that a humorless and comma-pointing leader is a peril to any institution.

Among the titles by which he was addressed he liked best that of "Commodore." From 1923 onward he was Commodore of the Eastern Point Yacht Club at Gloucester, Massachusetts, having founded the club, written its by-laws, and imparted to its membership, particularly the younger element, his fine spirit of sportsmanship. His smiling welcome was most conspicuous and inviting in the presence of young people, who were attracted to him, sought his company, and addressed him familiarly and affectionately. His kindly disposition was manifested no less in his numerous philanthropic activities.

In the history of the Society advances have been made at times by individual effort and the power of a single personality. We recall the great benefits conferred upon geographical science by Judge Daly, who for 35 years served as President. President Greenough depended rather upon the principle of association of effort. It is his monument that he used his gifts effectively in supporting a program of scientific work. He had pride in the widening recognition of that work and to the end followed its development with a friendly and personal interest. That interest is built solidly into the Society—in its traditions and in its purpose to serve education primarily through research.

THE INTER-AMERICAN HIGHWAY RECONNAISSANCE IN CENTRAL AMERICA

E. W. James and D. Tucker Brown
U. S. Bureau of Public Roads

FIG. 1

To civilized man, at least, the Central American isthmus has been no bridge connecting the northern and southern portions of the New World. "Few men, if any, have traveled by land from one continent to the other, and the accomplishment of such a journey even now would be a major undertaking for an exploring expedition"—an observation that still is true.[1]

The potentialities of the isthmus as a highway have, however, been appreciated. Fifty years ago the talk was of an intercontinental railroad. That scheme is far from being realized, though much valuable work has been accomplished by its various surveys. Attention has since been turned to a method of transportation more flexible and less costly in the first instance. It was eleven years ago that the project of an international highway first came under official consideration, at the Fifth International Conference of American States, at Santiago, Chile. There followed a series of conferences and recommendations culminating in the provision by the United States in 1930[2] for a survey "as to the feasibility of possible routes, the probable cost, the economic service, and such other information as will be pertinent to the building of an inter-American highway or highways." The survey was entrusted to the United States Bureau of Public Roads. It was begun in 1930 and finished in 1933.[3]

Practical considerations of time and cost had limited the initial undertaking to that section of the 10,000-mile route that traverses the Central American republics. Here, where a closer union is so eminently desirable and desired—as the several attempts at federation show—a considerable mileage of completed highway was already in existence. In Mexico about half of the 1600 miles has been completed, and in the Central American republics there is a considerable

[1] R. S. Platt: Central American Railways and the Pan-American Route, *Annals. Assn. of Amer. Geogrs.*, Vol. 16, 1926, pp. 12–21; reference on p. 12.

[2] E. W. James: The Present Status of the Inter-American Highway, *Bull. Pan Amer. Union*, Vol. 65, 1931, pp. 719–730.

[3] E. W. James et al: Report of a Reconnaissance Survey for the Proposed Inter-American Highway from the Republic of Panama to the United States, made under the direction of the United States Bureau of Public Roads, transmitted to Congress, March 6, 1934, MSS., 12 vols. In addition to the technical discussion there is an excellent economic section for each country.—EDIT. NOTE.

mileage of modern road construction in El Salvador, Costa Rica and Panama. But as yet only two of the Central American republics have been connected by highway—Guatemala and El Salvador.

Benefits of Through Communication

The object of the survey was to determine the route that would best serve as a continuous international connection through the

Fig. 2—The Volcan de Chiriquí (11,000 feet), rising from Chiriquí plateau, here at an elevation of about 5000 feet.

republics. Economic service, including passenger and commercial traffic, opening the way to wider settlement, and the extension of existing highway facilities were more important considerations than that of length. These conditions, as well as actual development of the several republics, required that the proposed highway cross a number of areas inaccessible except over very poor trails. In consequence the 2450-kilometer route between Panama City and the southern boundary of Mexico passes through practically the entire range of topography presented by the region.

As the subsequent description will suggest, the traveler along the route would find no two consecutive days alike as regards scenery or climatic conditions. The hot jungle lowlands; the dry, almost semiarid plains of Honduras; the high, salubrious plateaus of Guatemala and Costa Rica; the prairies of Guanacaste Province and the rich interior valley of the Río General in Costa Rica; and the unique plateau of Chiriquí in Panamá, where all the berries, fruits, and vegetables of the temperate zone appear to thrive—these present a series of changes of great variety and interest.

The entire region is rich in attractions for the tourist. In Mexico, Guatemala, and Panamá, archeological remains are numerous. Within seventy-five miles of Mexico City there are to be found probably more remains of a vanished civilization than in any equal area in the world. In Guatemala, Costa Rica, and Nicaragua there are magnificent volcanoes—along the southern rim of the Guatemala plateau no less than 18 specifically named cones, several of them as perfect as Fujiyama, if not quite so beautiful in their setting. Lake

FIG. 3—The Chorcha falls, Panamá, one of numerous falls along the Pacific slope of the Central American plateau along the proposed highway route.

Atitlán has been said to rival the Swiss-Italian lakes. Along the Pacific slope, largely followed by the surveyed route, there are numerous falls where the short mountain streams descend to the coastal plain. Traditions, customs, and the manner of life are Indian and Spanish, furnishing an atmosphere more distinctly foreign than that of many of the countries of northern Europe.

At present cities and populous rural settlements adjoin vast areas of sparse population or quite empty lands. The great agricultural potentialities of Central America are not yet realized. Concentration of effort has been put into two crops—coffee on the higher lands, bananas on the lowlands of the Atlantic slope. The value of these two commodities is over 90 per cent of that of all exports from the six republics. Reports show that many agricultural products now grown haphazardly, experimentally, or not at all would flourish in these regions of varied soils and climates. As regards the economic interests of the United States, possibilities do not end here. We have long been dependent upon the Far East for certain commodities that we do not produce or produce only in quantities insufficient for

domestic requirements—hard rice, tea, and cinnamon and other spices and condiments; camphor, quinine, and other medicines and drugs; rubber and copra; palm-nut and other vegetable and essential oils; varnish gums, such as copal; abacá hemp; and insecticide plants. There is evidence to show that, with the application of scientific methods and with enough capital, all these commodities could be produced in large volume in Central America. And again, though agriculture will no doubt continue to be the mainstay of the region, one should not overlook the possibilities of lumbering, with vast hardwood forests still undeveloped, and of mining, with mineral resources whose extent is still undetermined.

Existing highway construction south of Mexico City clearly indicates that in the several countries the preferred line of intercommunication and internal development is along the Pacific slope or on the Pacific side of the mountain plateaus. The available meteorological data show that the rainfall on the Atlantic seaboard, both for the year and for the rainy season, is about twice that on the Pacific slope. Practically all the centers of population on the Atlantic side are seaports, served by shipping facilities and devoted to localized export trade. A line closely following the Caribbean shore would be much longer, would involve a considerable area of swamps and marshland, and would necessitate crossing the largest streams in every country at points not far removed from their mouths. Furthermore, a general route along the Atlantic slope would make it difficult or quite impossible by a reasonable line to include the republic of El Salvador.

The route as laid out by the reconnaissance survey would serve a large part of the population in each country. Estimates based on provincial populations show the following percentages:

Panamá . . .	66	Nicaragua . .	53	El Salvador . .	66
Costa Rica . .	70	Honduras . .	27	Guatemala . .	55

These figures are based on the census records available by provinces; but the considerable fractions of the inhabitants living in the provincial capitals, pueblos, and *barrios* strung along the route indicate that except, perhaps, in Honduras, about half the entire population of Central America would be within a ten mile belt along the road. All the national capitals and most of the largest towns in the central areas and on the Pacific watershed would be connected. In Honduras the connection would be effected by a spur road from San Lorenzo to Tegucigalpa. Moreover, the highway would itself attract population.

Collaterally a highway would benefit aerial transportation. The ground line would serve as a guide and an aid in the location of airports and emergency landing fields.

The Route in Panamá and Costa Rica

The proposed route will now be briefly described. It crosses the Panama Canal by a ferry line at Balboa basin, near the Pacific entrance, and continues westward along the coastal plain. The old

Fig. 4.—Map of Central America showing the area covered by the aerial reconnaissance survey for the proposed inter-American highway. Scale approximately 1 : 10,000,000.

route into the western provinces of the republic crossed by ferry at the Pedro Miguel locks and twice crossed the continental divide. The new route avoids the long, winding climbs through the hills and substantially reduces the distance to La Chorrera, the first town of importance after leaving the Canal Zone.

The Republic of Panamá has already surveyed and practically completed a main highway for over 300 miles to Concepción, for the most part at elevations between 200 and 400 feet. At Concepción the proposed route turns northward and runs along a spur of the Volcán de Chiriquí, a beautiful peak some 11,000 feet high. The ridge location is followed for 19 miles on a well sustained and uniform gradient to the plateau (El Hato) at the base of the volcano, at an elevation of 4375 feet. From the plateau the route turns westward in a generally descending line across the Río Chiriquí Viejo, where

the elevation drops to about 3200 feet; then rises to 3650 feet on the Santa Clara ridge, between Chiriquí Viejo and Brus rivers. The international boundary follows this divide more or less closely. From here the route descends along another narrow ridge, known as the Sábana de Limón, largely open grasslands and with no adverse grades, to the point at the *barrio* of Paso Real where the Brus and the General join to form the Río Diquis. The line here runs through very rough country, except along the main ridge: a railroad with low gradients would be very costly; but a highway could be built with grades not exceeding 6 per cent. W. F. Shunk, surveying for the Intercontinental Railway Commission, found this region around the boundary between Panamá and Costa Rica to be almost impenetrable[4] and had to resort to an extemporized method of measuring distances by sound.

From Paso Real, on the Río General, the route follows the right bank of the stream for a distance of about 65 miles, rising from an elevation of 400 feet to 3850 feet at the divide between the Río Pacuaré and the right branch of the General and the Río Savegre. The Brus flows northward, the General southward, both in valleys behind the coast range, to form the Diquis, which turns abruptly toward the Pacific, cutting through the intervening range in a canyon. The system suggests a replica on a small scale of the Sacramento and San Joaquin rivers of California, but with differences in elevation greatly exaggerated.

The General Valley is reputed to be capable of unusual development, although it is relatively little known even to Costa Ricans. Shunk did not make a location through it but followed the coast, although he knew of the valley and its potentialities. Engineers on the survey coming into the valley from the north rode for hours through untouched hardwood forests. The river bottoms appear to offer excellent possibilities for tobacco culture, especially of Sumatra grades, and the arable lands along the banks invite settlement. But at present the valley is isolated and almost uninhabited. Shunk described the region as harder to penetrate than any he had found in the high Andes of Peru.

From the Savegre divide, at the head of the General Valley, the reconnoitered line enters a region of spurs from the main cordillera that extend practically to the shores of the Pacific. The streams flow in direct courses and have steep profiles. The line crosses the Savegre and the Naranjo and proceeds up the Río Parita to San Marcos and to a point beyond called El Jardín, which is on the continental divide at an elevation of 7275 feet. The route follows the crest of the divide in more or less open meadow lands for 25 miles

[4] [Report of the] Intercontinental Railway Commission, Vol. 2, Report of . . . Corps No. 2 in Costa Rica, Colombia, and Ecuador, 1891–1893, Washington, 1896, p. 91.

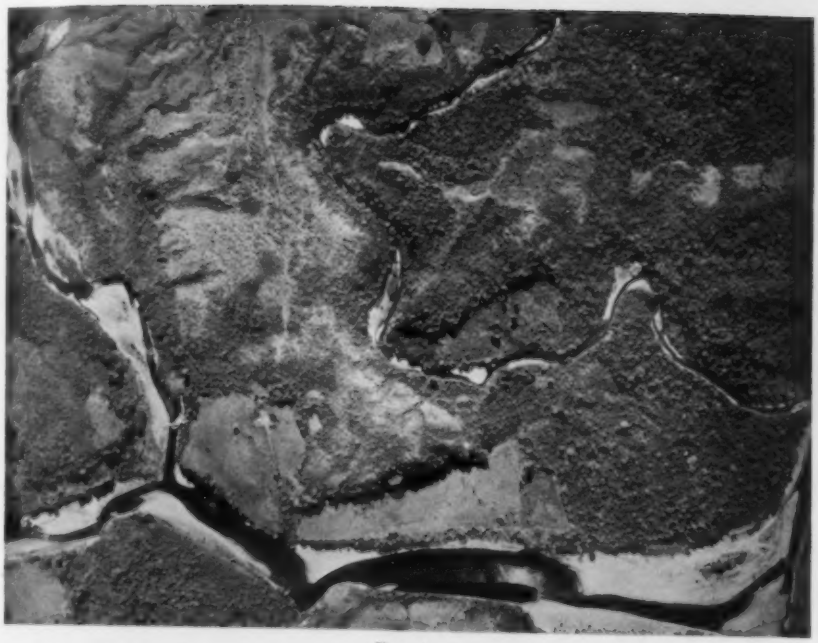

FIG. 5

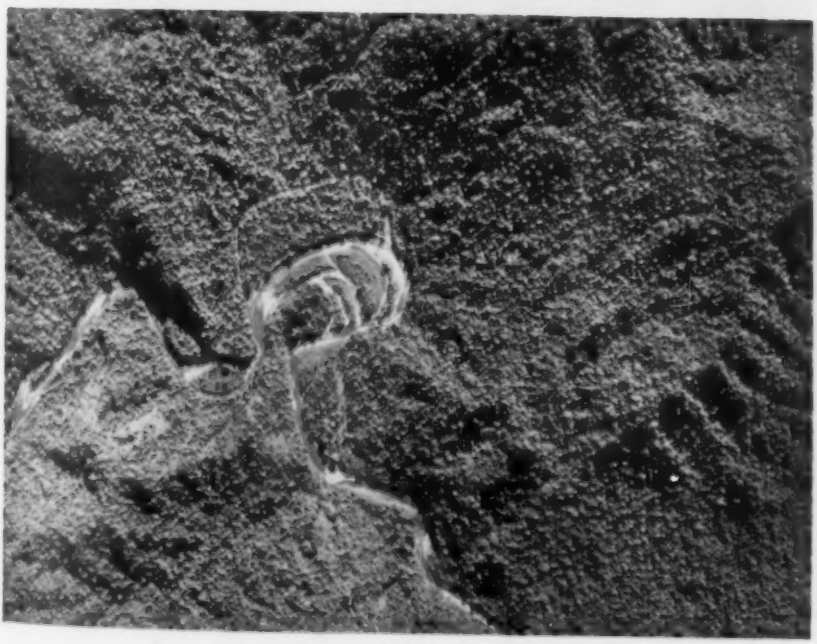

FIG. 6

FIG. 5—The toe of the Sabana de Limón between the Brus and Limón rivers at Paso Real, where the Brus and General meet to form the Río Diquís.

FIG. 6—Highly dissected slopes along Río Savegre. The roughness of the topography shows clearly through the heavy forest cover.

and at El Alto (5125 feet) makes a junction with the main highway of the Meseta Central, which crosses the continental divide between San José and Cartago and is itself of modern design.

The Meseta Central, the garden of Costa Rica, supports 90 per cent of the population of the country. It is a region of intensive

FIG. 7—General view of David, Panamá, 310 miles from Panama City. The surrounding territory is typical of the coastal plain in western Panamá.

cultivation, of large and small coffee plantations, and is especially notable in Central America for the large proportion of landholding farmers.

At a point near the town of San Ramón the descent from the plateau begins, and it continues through Esparta (600 feet) for a distance of 28 miles to the Río Barranca (200 feet) in the Pacific coastal plain. The route then skirts the foothills for 98 miles, crossing many small streams that rise in the central cordillera. The cordillera rapidly declines in height and width as the San Juan Valley is approached. The elevation across the plains of Guanacaste does not rise above 400 feet and for 39 miles beyond reaches a maximum of only 950 feet in crossing the continental divide into the watershed of the Sapoa, which carries the line down to Lake Nicaragua at an elevation of 110 feet. These Guanacaste plains have given good evidence of their value as grazing lands, but the cattle lose 25 per cent in weight on the overland drive to market.[5] Rice can be raised in Guanacaste, but at present it is cheaper for San José to import it from the Orient.

[5] Cf. H. H. Bennett: Agriculture in Central America. *Annals Assn. of Amer. Geogrs.*, Vol. 16, 1926, pp. 63–84. "Fine hogs were seen in the San Carlos River section of northern Costa Rica . . . Some claimed that at these long distances from market it was usually best to carry out only the lard" (p. 80).

The Route from Nicaragua through Guatemala

Throughout Nicaragua the route lies in the Atlantic watershed, but actually near the Pacific, being between the lakes and the sea. This is the most densely settled part of the republic. A string of cities and small towns extends along the railroad northwestward

Fig. 8—General view across the Meseta Central in Costa Rica from above Santana landing field.

to Chinandega, and the highway must necessarily follow the same general line or pass entirely on the opposite side of the lakes. For more than 200 miles the elevation is not over 900 feet at any point, and generally not above 400. Near La Paz, Nicaragua, transition is made from the Atlantic to the Pacific slope over an almost imperceptible rise. At the Río Negro, Honduras is entered. This section of the line, 80 miles long, follows the low coastal plain, in some places being only a few miles from the shore; but in El Salvador the route enters an inland valley behind the coastal range. It climbs a series of cross ranges at elevations of from 2400 to 3000 feet with a drop to 100 feet at the Río Lempa. As the Guatemala boundary is crossed, the line leaves the region of low elevations and again enters the cordilleran valley, rising from the last depression in El Salvador at 1700 feet to 6200 feet at San Vicente, Guatemala. Here the main divide is crossed and the line drops from the edge of the uplands to 4950 feet at Guatemala City. Behind the range with its series of volcanic peaks the route continues to rise again as it leaves the Guatemala Valley to find a way out northwestward to the Pacific lowlands. Little adverse grade is experienced as the elevations increase to 7025 feet near Patzicía, to 9900 feet just beyond Tecpam, and finally to 10,550 feet at Las Flores, where is reached the maximum

elevation of the route between the United States and Panamá. At Palo Gordo the elevation is 8200 feet, and from this point a sustained grade brings the line down to 1000 feet at the Suchiate River, which marks the Mexican boundary.

Drainage Conditions and Bridges

Drainage conditions along a route so varied in a region having a heavy annual precipitation confined to a rather definitely limited

Fig. 9—Bad lands in the semiarid section of Honduras contiguous to the highway between San Lorenzo and Tegucigalpa. The proposed line of the inter-American highway avoids this impossible terrain by keeping to the southwest along the Pacific coastal plain.

rainy season must be expected to present some difficulties. Between David, Panamá, and the Mexican border at the Suchiate River 189 bridges are called for, of which 52 will have to be longer than 100 feet. The longest structures required are the bridges over the Río Lempa (1000 feet long) and over the Guascorán. In all, 20,070 feet of bridging will be needed, in spans of 40 feet or more. The greatly dissected terrain that exists everywhere along the route, either on the line itself or near it, will require a heavy installation of smaller structures, including culverts, totaling more than 699,000 linear feet. While this bill of structures is formidable, it does not contain so many major bridges as would be demanded by a line along the Atlantic side, where many rivers would be crossed in their lower reaches. The number of culverts for local drainage would be somewhat less on the Atlantic watershed, as the slopes are flatter and run-off has a chance to reach the larger drainage channels. But most of the streams on the Pacific side are torrential, and flood elevations

are not high. Incidentally, many of the smaller streams along the route may be developed to furnish intermittent water power of local value. The larger streams are, of course, capable of much greater development whenever a market for power becomes available.

The Aerial Survey

The Bureau of Public Roads began its survey in July, 1930. As a preliminary to field operations a general study was made of the entire

Fig. 10—Crossing of the Río Guascorán near the town of Guascorán between Honduras and El Salvador. The cross in the middle ground is a white cloth marker for the aerial survey.

area to be traversed, with special reference to its topography, meteorology, and drainage. For much of the area the available maps were found to be inaccurate in scale and meager in detail. To have resorted, through the jungle and over the rough mountain topography existing generally in the undeveloped sections, solely to the usual methods of making ground surveys for the purpose of reconnaissance maps would have been very costly in both time and money. It was, therefore, decided to base the reconnaissance maps on an aerial survey. An arrangement was made with the U. S. Army Air Corps located at France Field in the Canal Zone to do the necessary flying and to furnish films and prints. No work was done over El Salvador because adequate surveys were available through the public-works authorities of that country.

Two types of aerial cameras were used, known as K-3 and T-2 types. The former has a single lens and takes a vertical picture; the latter has four lenses and takes simultaneously one vertical and three oblique views—one oblique to each side, and one to the

rear, of the vertical. The type of camera to be used over any terrain is governed largely by the ground conditions and the information desired. It was accordingly necessary to make the usual reconnaissance on the ground, using the customary instruments for such work, including in some cases stadia surveys, and it was important that very full and descriptive notes be taken of the desirable line found

FIG. 11—Acatenango and Fuego, two of the eighteen principal volcanic cones on the southwestern rim of the Guatemalan plateau.

on the ground, giving special attention to outstanding points that later could certainly be identified in the photographic prints.

The K-3 camera, which takes only vertical views, is especially satisfactory where a definite ground line, visible from the plane, can be followed, or where alternate locations require the inclusion of an area, thus necessitating two or more parallel flights. For this reason the K-3 type was used from Panama City to El Hato, since throughout the entire distance an existing highway in the Panamá national road system could easily be followed. Between El Hato and a point on the continental divide near Cartago, Costa Rica, the survey was largely through undeveloped and inadequately mapped territory, so that it was necessary to build up mosaics covering large areas and showing a considerable amount of detail. The extent of the areas to be covered was determined by the several reconnoitering trips of the ground party.

From El Alto, near Cartago, to Naranjo the route follows an existing highway, and this section was covered by a K-3 camera in a single flight. From Naranjo to Esparta, Costa Rica, the country is again rugged and offers a choice of routes, and here also it was necessary to make several parallel flights with the K-3 camera and to build up mosaics.

Northwestward from Esparta the reconnaissance on the ground

showed that a feasible route would traverse open or sparsely wooded country, would cross numerous streams at points selected as adequate bridge sites, and for long distances in Nicaragua and Guatemala would follow existing wagon roads, sufficiently traveled and worn to be visible from the air. But the possibility existed of having to make many relocations or diversions in rough country to secure

FIG. 12—Coniferous forest on a section of the highway in Guatemala.

improvement of unsatisfactory alignment and grades along existing roads. Therefore, the T-2 type of camera, which covers about 8 miles in width when flying at 15,000 feet, was used, satisfactorily, throughout the remainder of the flights northward from Esparta to the Guatemala border. Inasmuch as the flights were made at an approximately constant altitude of 15,000 feet, it is obvious that in the higher elevations in Guatemala the width of area was reduced considerably below the 8 miles, but, fortunately, in those regions the population is densest, the towns largest and most clearly distinguishable, and the existing cart roads more easily followed; also, the region is a plateau requiring less area for development of line than if the slopes of the cordillera were followed.

With the exception, therefore, of one or two short sections where the flyer could not photograph because of low visibility, the entire distance from Esparta northward to the border was covered by a single flight. Supplementary flights to fill out the short sections missed were made later.

It should be kept in mind that the aerial survey was primarily for the purpose of verifying and supplementing data on existing maps and supplying information on which maps could be based where none were available. No exploratory flights were needed, and the prints and mosaics could be used directly as the basis for plan and profile sheets of sufficient accuracy of detail to serve the purposes of a

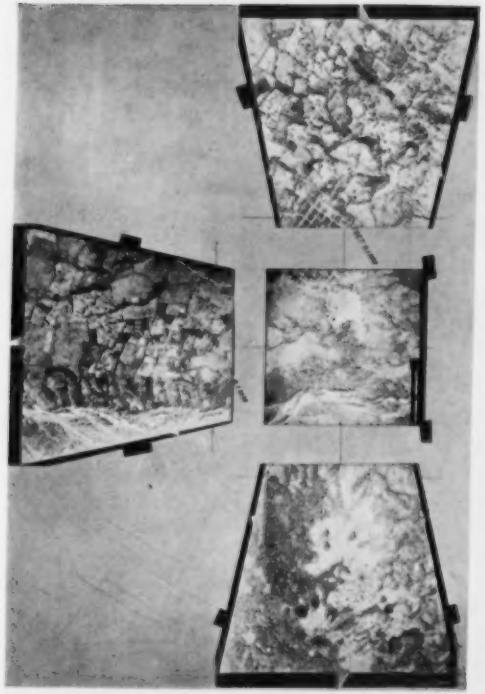

FIG. 13

FIG. 14

FIG. 15

FIGS. 13 to 15—Some of the stages in construction of the mosaic map. Figure 13 shows relative position of central and transformed oblique pictures (T-2 camera), forming a composite picture. Figure 14 shows mosaic built up from sections of composite pictures showing reconnaissance line and lettering directly on the mosaic. Figure 15 shows final picture of mosaic ready for mounting in bellows form (see Fig. 1).

reconnaissance-survey report. As a detailed ground reconnaissance was made over the entire route and elaborate notes taken that would facilitate placing the selected highway line on the mosaics, it was not essential that the planes maintain a constant elevation above the average altitude of the terrain, but they could be flown at an approximately constant altitude of 15,000 feet. The ground reconnaissance furnished information sufficient to provide control for the flights and for subsequent compilation of the data. The controls were carefully selected with relation to the proposed line, and, where necessary, sketches were furnished the flyers. Occasionally easily identifiable points were not available, and it was necessary to establish artificial points by staking down on the ground strips of white cotton cloth in the form of squares, triangles, or crosses, large enough to be seen from the air (Fig. 10). In one or two cases such artificial markers were established in the tree tops, where the forests were dense.

This method of flying at practically the same altitude at all times naturally resulted in differences of scale in the pictures, because the ground surface elevations varied from about sea level to nearly 11,000 feet. The adjustment of scales is discussed later.

Construction of the Map

Because the overlap of the assembled prints in some cases was less than 50 per cent and because adequate ground control was not available, the usual method of aerial-map construction could not be followed. Even if the overlap had been adequate, the time and cost of securing additional ground control and of conducting photo-triangulation by what is known as the radial-line method did not seem to be warranted in a reconnaissance survey. It was therefore decided to make uncontrolled mosaics by matching images and to reduce the mosaics to a uniform scale by taking advantage of such ground control as there was and by various expedients where no control existed.

The single-lens prints were made into mosaics by the usual method of matching images, and no particular difficulty was encountered in joining parallel flights except where the relief was great. Mosaic making from composite prints of multiple-lens photographs is, however, difficult even in a single flight, and it is almost impossible to match parallel flights where there is considerable difference in relief. However, all of the line surveyed by means of the T-2 camera was covered by single flights, and it was decided to make strip mosaics from the composite pictures by adopting a method that would give an accuracy consistent with the object sought without the expenditure of too much time and labor. The method used is believed to be the simplest so far devised for such purpose.

ed mosaic ready for mounting in bellows form (see Fig. 1)

The composite picture first to be used was cut on a straight line near its forward edge through certain well defined points, preferably not less than three, such as the fork of a road or trail, the corner of a cultivated area, a sharp bend in a stream, or the point of a sand bar, that could be easily located on the next composite picture to be used. It is important that these points be actually on the ground and not confused with trees or other growth or with high objects that cause deceptive shadows, for points above the general ground level do not look the same on different prints or when viewed from different angles. It is also desirable, if only three points are selected, to have one on each of the two wing pictures and one on the base picture.

The cut edge of the first composite picture was then placed immediately over the corresponding selected points definitely located on the next picture. A very fine line was drawn through the points and the second composite cut as described. The first and second pictures brought together on the cut lines produced a continuity of terrain, and, if all the points were in line and accurately identified, there was proper orientation. The second composite was then cut near its forward edge through a new set of identifying points and the process continued. To reduce the number of strips, the strip cut from the composite view was always made as wide as possible. The strips were then mounted in mosaics of workable size. Where overlap is great it may be necessary to use every consecutive composite picture. Care must be exercised, however, to make sure that the wing pictures join. It frequently happens, especially where the course of the plane is changed, that the wing picture on the outside of the curve will not show the necessary identifying points unless it is consecutive. In such cases it is desirable to use strips from all pictures, even though they are narrow, rather than to cut gores from the intermediate wing pictures.

It sometimes occurred that three points in a straight line were identified and marked on one composite but on the next picture these same points were found to be not in line. In such cases it was necessary to hold to the point nearest to the line of the projected survey and make adjustments as required at the other two points. This gave the greatest accuracy of detail in the terrain close to the line.

Such misfits, however, tend to cause loss of control of direction in the orientation of the mosaic as it progresses and put into question both directions and distances between related points of the mosaics. Control must be maintained by checking the direction between known points, and, to insure the maintenance of proper orientation, this may frequently make it necessary to lay out on a large drafting table a long series of composite pictures or mosaics or both. The rear, or tail, obliques are helpful in checking direction, as they permit the use of a longitudinal line through selected points

on successive prints. In the present survey latitudes and longitudes of enough points to furnish general control of direction were known, and results obtained by their use were, in most cases, satisfactory. In a few instances it was necessary to determine directions by compass for local control.

Since scales of the composite prints vary with the elevation of the terrain covered, the scale of the mosaics will also vary, and, as these are built up from a number of composites, there will be a variety of scales on any mosaic. Therefore, before the mosaics could be used in the preparation of uniform-scale drawings for line and profile, an average scale accurate enough for use on each separate mosaic had to be determined, and, similarly, one for a series of adjacent mosaics. This was accomplished by selecting points of known geographic location that could be readily identified on the pictures—preferably as near the center as possible—and on existing maps and charts, from which the distances could be computed or scaled and comparison made. Occasionally, when several mosaics were thus fitted together between points of known location that were a considerable distance apart, it was found that the distances between the known local control points used in the adjustment of individual mosaics did not conform to the distances taken from available maps. In such cases it was necessary to adjust the individual mosaics, and it was largely a matter of judgment as to where the adjustment should be made. In a few cases, where no definite control points could be located on either available maps or mosaics, a stadia traverse was run in order to determine the local scale.

The same scale could not, of course, be used throughout, and a variety of scales were used for areas of low, high, and intermediate elevation, with many sections of varied elevations for which average scales of less accuracy had to be adopted. The roughest area in the survey was in the region of the Río Savegre in Costa Rica, and through here the greatest local fluctuations in scales undoubtedly occurred in the mosaics. In a distance of 110 units (about 35 miles) the error was 1.7 per cent, which was the maximum disclosed in any of the comparisons made. The scales of the flight pictures, and therefore of the mosaics, ranged from 1 : 10,000 to 1 : 23,000, two different lenses having been used.

After the mosaics had been completed, the reconnoitered ground line of the highway was platted on in black India ink, which tests had shown to give the best photographic results. Before the line was platted, either the mosaics or the composite prints were placed under a stereoscope, so that the engineer, with his field notes before him, could plat the reconnoitered line following along the streams, around the hills, and through the gaps. With the line of the highway on the mosaics, it was possible to frame the sheets to be used in the report

(Fig. 14). The names of cities, towns, streams, etc., the mile and kilometer points, and other data were put on in black ink and the framed sections of the mosaics photographed to the same size (Fig. 15). The prints were trimmed to bring the alignment into continuity and the pictures mounted on strips of cloth and folded into a bellows form (Fig. 1), the length of the bellows depending upon the directness of alignment.

Plan and Profile Sheets

The mosaics were then reduced by pantograph to a uniform scale of one inch to 4000 feet. This reduction of scale—roughly one-third—served to minimize unavoidable errors resulting from the composition of the mosaics and from the use of computed average scales over broken and irregular ground. The discrepancies occurring by the use of this method, however, appear to be of so little importance that it is not believed necessary or advisable to expend time and labor in the field to correct them. The proposed route line was shown together with cities, towns, villages, streams, and such other physical features as were considered advisable (Fig. 16). Data for the profiles shown on the plan and profile sheets were obtained on the ground by aneroid readings.

Finally a rather elaborate index of maps, mosaics, pictures, film rolls, and other records was prepared.

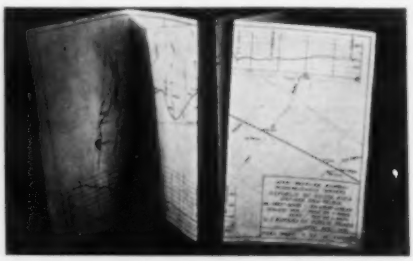

Fig. 16

THE COLUMBIA PLATEAU REGION OF COMMERCIAL GRAIN FARMING

John H. Garland
Ohio State University

LARGE fields of wheat and great blocks of clean fallow are by far the most conspicuous cultural features in the landscape of the rolling hill country of the Columbia Plateau. Landholdings are large; and here and there at widely separated intervals a ranch house and its buildings, surrounded by Lombardy poplars, break the repeated undulations of bare hills. An occasional village, with its grain warehouse and stacks of sacked wheat, is clustered in a notch in the hills where stream activity has provided a small level space. In this region of rather scanty rainfall small streams follow devious courses through steep-sided valleys of loess, while the larger ones have removed entirely the deep, wind-blown soil and left exposed the underlying basalts. Along these comparatively flat valley floors not only the streams but also the roads and railroads twist and curve from one small village to another.

The plateau is a region of commercial grain farming devoted largely to the raising of wheat. The ranches, ranging in size from about a half section (320 acres) to well over three square miles (1920 acres), are operated for the most part by their owners; only about 25 per cent are tenant operated. Although most of the cultivated area consists of slopes, some of which are very steep, machinery tractor drawn in contour fashion is extensively used. The wheat, seeded by drilling in soil that has been fallowed for one or two years, is harvested by a huge combine. Many horses or a caterpillar-type tractor draws the machinery along the side of a hill, heading, threshing, and sacking the dry wheat in the field, leaving the straw standing to be burned in preparation for the next clean fallow. Yields range from about ten to more than thirty bushels an acre.

Definition of the Wheat Region

A rather high proportion of the wheat region of the plateau is under cultivation: the northern part and the upper valley of the Snake River are the outstanding sections of the three states of Washington, Oregon, and Idaho in the extent of land in crops. Figure 2 shows an orderly increase in percentage of cropped land towards the central part of the northern plateau to a maximum in Whitman County in eastern Washington, where the average is 72 per cent. Furthermore, wheat is the most extensively and widely grown crop in these areas.

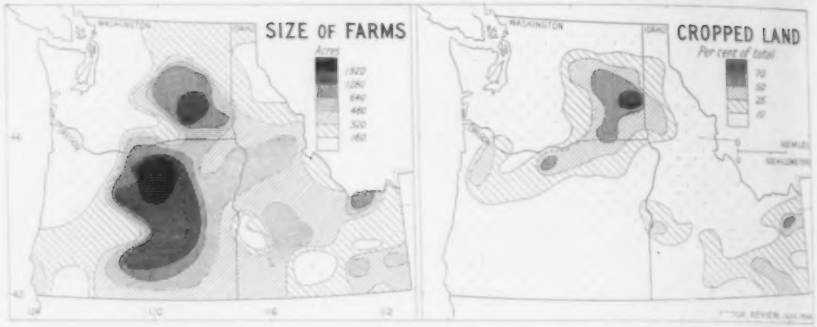

FIG. 1 FIG. 2

FIG. 1—Isopleth map showing the average size of farms in the Pacific Northwest.
FIG. 2—Isopleth map showing the percentage of total land area of the Pacific Northwest in all crops.

The development of the wheat region is shown below in Figure 3. By 1890 wheat growing was well started in the northern part of the plateau. Previous to that time the crop in the Pacific Northwest was localized in the Willamette Valley of western Oregon, which then produced about four times as much wheat as Washington and Idaho together. As more and more of the old cattle country was put under cultivation the relative importance quickly changed: although the acreage under wheat in western Oregon decreased only slightly, that in the northern plateau increased rapidly. By 1910 the Columbia Plateau wheat region had developed to its present size and importance. In general, the greater the percentage of arable, the greater is the proportion used for wheat. In that part of the northern plateau where from 50 to more than 70 per cent of the entire area is in crop more than 45 per cent of the cropped area is in wheat.

This region of extensive wheat production is also outstanding in the Pacific Northwest in the value of crops produced. The value of cereals alone, in comparison with the value of all agricultural products, stands high in the wheat region. In fact, in no place within the entire area where at least one-tenth of the acreage of the cropped land is in wheat does the value of cereals fall below one-fourth of the total value of all field and orchard crops. In that portion of the plateau

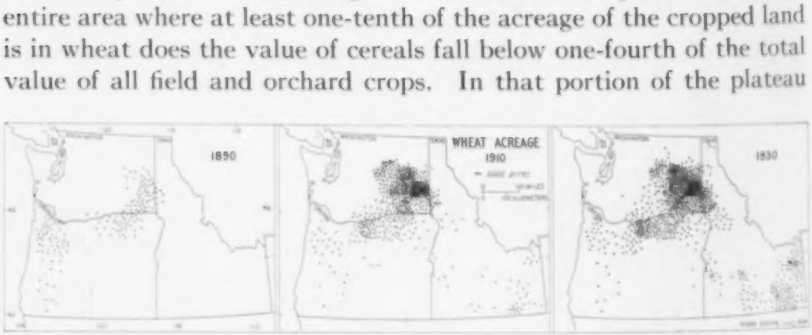

FIG. 3—Dot maps showing the wheat acreage of the Pacific Northwest in 1890, 1910, and 1930. One dot equals 5000 acres.

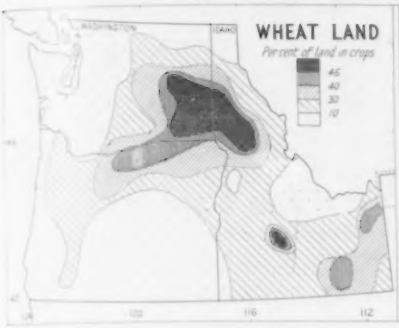

FIG. 4

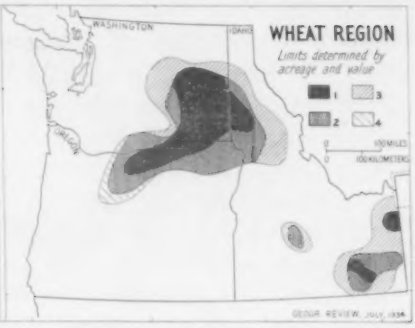

FIG. 5

FIG. 4—Isopleth map showing the percentage of cropped land in wheat. A comparison with Figure 2 emphasizes the importance of wheat growing in eastern Washington.

FIG. 5—The wheat region of the Columbia Plateau as derived from a combination of three isopleth maps: a, 25 per cent or more of the total area in crops; b, 30 per cent or more of the cropped area in wheat; c, 50 per cent or more of the value of all crops in cereals. Grade 1, the wheat region *par excellence*, combines a, b, and c; 2 combines b and c; 3 is b only; 4 is c only.

where wheat production is densest cereal values rise rapidly to 50 and 75 per cent of the value of all agricultural products and, in several sections devoted almost exclusively to wheat raising, to more than 90 per cent. Since this region is so decidedly a single-crop area, the distribution of cereal value is a useful criterion in delineating the wheat-growing region.

The limits of the wheat region as they appear on the map, Figure 5, are based on the percentage of total area in crop, the amount of cropped area in wheat, and the value of cereals in relation to all crops. The heart of this commercial grain-growing region may be defined as the area in which 25 per cent or more of all the land is under cultivation, at least 30 per cent of the cultivated land is in wheat, and at least 50 per cent of the value of all field and orchard products is realized from cereals. This means that within the dense portion of the wheat region at least 160 acres of each section (640 acres) are under cultivation, and of this 160 acres wheat is grown on 48 acres. Cultivated land increases from this minimum to 480 and even to about 575 acres of each square mile, while wheat acreage progresses to about 215 acres of each 480 acres cultivated. Although this proportion seems relatively small, it should be recalled that because of dry fallowing only about one-third to one-half of the cultivated land is in crop each year. Surrounding the cen-

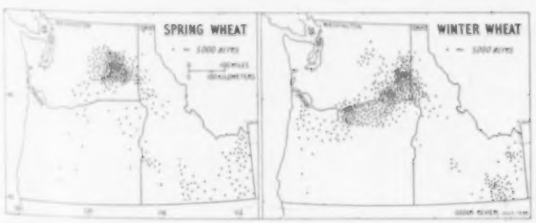

FIG. 6—Dot maps showing the acreages of spring and winter wheat respectively. One dot equals 5000 acres.

tral portion of the wheat region, which is largely in eastern Washington with extensions into northern Idaho and northeastern Oregon, is a peripheral zone in which one or more of the criteria upon which the heart of the wheat area was established fall below the assigned value. Thus on the southern periphery less than 25 per cent of the total area is arable, though it is a single-crop wheat area. On the northern and western periphery also less than 25 per cent of the total area is used for agricultural activities, and, furthermore, cereal values do not reach 50 per cent of the total crop value. In a small area on the extreme southwestern periphery relative cereal values are maintained, though the area cropped and the proportion devoted to wheat are relatively reduced—60 to 70 acres out of each 640 acres cultivated, with wheat on from 15 to 25 acres. In two small areas of the upper Snake Valley wheat production reaches the importance maintained by the heart of the wheat region in the northern plateau.

Both spring and winter wheat are grown throughout the entire area, though their relative importance varies from section to section, ranging from 90 per cent spring wheat in the extreme northwest to 90 per cent winter wheat in the extreme south (see Fig 6).

Climatic Qualifications

The wheat region occupies the more favorable parts of a much larger physiographic region—a low, lava-covered, intermontane plateau, unique in some of its features. Save on the "scablands," a deep, undulating layer of loess covers the larger part of the plateau surface above the basalt. As on most intermontane plateaus, precipitation is light, but, because of the latitude of the region, it supports grass rather than a desertic vegetation, especially in the northern part. The windward slopes generally receive most rainfall, while shaded slopes have less evaporation and usually support more vegetation.

According to Thornthwaite's classification[1] the Columbia Plateau falls within five climatic provinces defined by the ratio of precipitation and evaporation. The area about the Yakima Valley and adjacent area, mostly outside the wheat region, is arid. The western periphery of the wheat region and also the Harney basin of Oregon and the Snake River plains of Idaho are semiarid. It is well to note that the two wheat areas in the upper Snake River Valley are associated with the subhumid humidity province. The eastern periphery is in the humid province of the mountain slopes of northern Idaho. The heart of the wheat region lies in the subhumid province, with a rainfall of between 10 and 20 inches a year. Its western part has a

[1] C. W. Thornthwaite: The Climates of North America According to a New Classification, *Geogr. Rev.*, Vol. 21, 1931, pp. 633–655.

precipitation deficiency in every season, and here dry fallowing is usually practiced for two years and a crop raised the third, while in the more humid part to the east a crop is raised every other year.

This is the steppe climate of Köppen[2]— a dry climate with a cold winter and a dry summer. About 40 per cent of the moisture falls in the three winter months, when evaporation is least. In the less severe winter temperatures of the southern part of the region winter precipitation helps to explain the predominance of winter wheat there. A light snow cover protects the wheat, which has sprouted the fall before in soil that holds most of the accumulated moisture of the previous year, and adds its moisture by melting the next spring when needed most for growth. In the region of spring-sown wheat precipitation of the previous season furnishes the larger part of the moisture upon which the crop is grown. In the dry, hot summer the crop ripens rapidly, producing a clean grain relatively free from diseases common to more humid regions. The straw stands stiff and straight, and, since the heads dry thoroughly in the sunlight, shocking to cure the grain is unnecessary, and power-driven combines are able to head, thresh, and sack the wheat in the field in one operation. The conservation of moisture in the soil by clean fallow is an outstanding agricultural practice over most of the region. Winter moisture, falling at the time of least evaporation, aids materially in this activity.

Types of wheat have been selected and new varieties developed that are best adapted to combine handling, whereby a few men are able to crop and harvest vast acreages. Club wheat of a soft type, which has stiff straw and does not shell out (Hybrid 128 was developed in eastern Washington), is commonly raised, while Common White, Soft Red Winter, and Hard Red Winter are also included. Although the combine is not exclusively used, most of the wheat is so harvested. The necessity of building large elevators is eliminated, warehouses generally taking their place.

The Wheat Soils

The formation of the deep, fine, loessial soils of the wheat region is still imperfectly understood. Various opinions have been expressed on the rôle of the wind, but it may reasonably be stated that the soil "useful in agriculture" has been largely wind borne.[3] The regular undulations lie like drifted snow, one slope usually long and gentle while the opposite is short and steep. Unevenness of surface is one of the elements of the physical set-up most to be reckoned with by the wheat farmer, especially in the eastern part of deep loess, where

[2] Wladimir Köppen: Die Klimate der Erde, Berlin and Leipzig, 1923.

[3] Kirk Bryan: The "Palouse Soil" Problem, with an Account of Elephant Remains in Wind-Borne Soil on the Columbia Plateau of Washington, *U. S. Geol. Survey Bull. 790*, 1927, pp. 21–45; reference on pp. 44–45.

the slopes are the steepest. An area in which slopes of 40 and 50 per cent occur can hardly be described as gently rolling. Yet, because of the great depth of soil, exposed rock is found in only a few of the deeper river valleys, and cultivation covers valleys and sides and tops of hills with apparent disregard for slope. Special machinery is necessary to operate on these steep slopes, which are traversed in contour fashion.

On the steep loess of the eastern part of the wheat area a first-class chernozem soil has developed. The subhumid climate supports a thick grass covering, which has produced the necessary thick humus layer in a dark lime soil of great fertility.[4] In this region of fine, deep soil of unusual steepness the generally dry climate and the infrequency of violent summer rains reduce erosion and impart to the soil a tendency to accumulate lime.[5] As is characteristic of a wind-deposited soil, the particles are fine and cling together well, thereby retarding erosion, especially where a deep humus caused by decayed grass roots is present. Dry fallowing also can be accomplished readily, for a fine, dusty surface that effectively retards evaporation is easy to maintain. Erosion, however, is a problem of some concern, especially on the steep north-facing slopes where snowdrifts accumulate on the loose fallow soil. There the snowdrifts remain long after the exposed slopes are dry. Erosion by nivation[6] occurs, and as a result cirque-like formations with steep concave slopes have developed on the shaded sides of the loess hills. Frequently no attempt is made to utilize these amphitheater-like slopes and they become choked with brush.

In the western part of the wheat belt and its periphery the loess is not so deep as in the eastern part, and the surface is smoother; the climate is less humid, the grass cover thinner, and the associated soil is the less fertile chestnut type. Especially in the western part of the wheat area the surface is interrupted by the channeled scablands,[7] which cover about 2000 square miles, or about one-sixth of the Columbia Plateau north of the Snake River. The scablands are erosional features, tracts of bare rock left by the removal of the loess cover. Since the loess was removed only from a multiple system of narrow channels, leaving islands of loess of varying sizes, wheat raising is carried on in the scablands, although production is much lower in this portion of the area.

To the east in Idaho the heart of the wheat region ends with the

[4] C. F. Marbut: Russia and the United States in the World's Wheat Market, *Geogr. Rev.*, Vol. 21, 1931, pp. 1–21; reference on p. 5.

[5] W. A. Rockie and P. C. McGrew: Erosive Effects of Heavy Summer Rains in Southeastern Washington, *State College of Washington Agric. Exper. Sta. Bull. No. 271*, 1932.

[6] V. R. D. Kirkham, M. M. Johnson, and Donald Holm: Origin of Palouse Hills Topography, *Science*, Vol. 73 (N.S.), 1931, pp. 207–209 See also this number of the *Review*, pp. 380–385.

[7] J Harlen Bretz: The Channeled Scabland of Eastern Washington, *Geogr. Rev.*, Vol. 18, 1928, pp. 446–477; *idem:* Alternative Hypotheses for Channeled Scabland, *Journ. of Geol.*, Vol. 36, 1928, pp 193–223 and 312–341, reference on p. 194.

FIG. 7

FIG 8

FIG. 7.—Aerial photograph of the Palouse country after the wheat harvest. The light-colored blocks are the areas from which the wheat has just been harvested, and the dark areas are the fallow lands. The marks of the combines are conspicuous. In the lower left, however, are fields in which the grain has been cut by a binder, for rows of bundles can be seen. The darkest spots in the wheat lands apparently are parts that have already been plowed after harvest, while unused spots on the erosion surfaces are medium dark. (Courtesy of 116th Photographic Section, Washington National Guard, Spokane.)

FIG. 8.—Road cut through a Palouse hill over fifty feet deep and entirely in loess. The slope to the right is covered with tall wheat stubble, the result of combine harvesting, the other is in fallow.

plateau, while the periphery follows the valleys up into the slopes of the Bitterroot Mountains. On the south a narrow elongation of the heart of the region extends westward from the Walla Walla plateau into Oregon along the valley of the Columbia River, while the periphery ends in the rough topography of the Blue and Wallowa mountains and the deep canyon of the Snake River.

The absolute limits of that region on the Columbia Plateau that can be called the wheat region are those places where the combination of environmental elements is so severe that it is no longer considered profitable to attempt to grow wheat as a cash crop. Whitman County in eastern Washington may be considered the core of the wheat region.

Transportation Problems

Economic, as well as natural, circumstances adapt the Columbia Plateau to wheat raising. Usually commanding a relatively high price, the crop can be shipped long distances and stored for long periods with little danger of deterioration, while machinery, by multiplying the efforts of a relatively small body of labor, permits extensive cultivation. The Columbia Plateau is remote from large markets, so transportation is an important question with any economic product of the region. It was not until rail transportation had reached the region that cattle grazing as the outstanding activity could give place to wheat raising. Marbut has stated that railway transportation, the invention of agricultural machinery, and a rapid increase in the industrial population of the western world entered into the combination of factors that caused the development and increase of extensive wheat growing in the grasslands of the world.[8]

Much of the wheat of the plateau is shipped westward by rail along the valley of the Snake and Columbia rivers to Portland, Ore., northward to Spokane, Wash., the metropolitan market of the wheat country, or directly westward to Seattle. In the past, barge transportation was important for areas adjacent to the Snake and Columbia rivers, and Asotin, Wash., at the northern end of the Snake River canyon, still depends on that means for transporting at least a part of the wheat of the district. Otherwise river transportation has been abandoned in favor of the railroad. In several places along the Snake Valley steel-cable tramways are used to lower the sacked grain from the plateau to the railways about two thousand feet below.

The Future

The future of wheat growing on the Columbia Plateau is occasioning some concern. The data used in this paper are census figures, returns of 1929. Since that time, as observations in the field in 1931

[8] Marbut, *op. cit.*, p. 5.

showed, the wheat acreage has been shrinking, and it undoubtedly has continued to do so materially. An agricultural region of a single crop, especially one poorly equipped for diversification, is quickly and severely affected by a sharp and continued decline in market price, and the condition is the more serious if the commodity enters a world-wide market, as wheat does. Diversification is not attempted except in the more humid eastern part of the wheat region where peas and alfalfa are frequently grown on the gentler slopes. Russia under the Five Year Plan has been of no small concern to the wheat grower of the Columbia Plateau.[9] Furthermore, an internal factor must be considered. Baker[10] expresses concern over the indefinite continuation of the present extensive single-cropping method on the grounds that constant growing of the same crop for the past forty or fifty years has greatly reduced the original fertility of the soil and consequently yields are falling. Since almost nothing is done to restore the fertility to the original high state, further decline is expected. Constant cropping has destroyed much of the humus content, thus making the soil more susceptible to erosion. Baker suggests farming of a more general nature with dairying and fruit raising but at the same time points out that a declining city population would contract the market for such products.

We might perhaps consider the wheat region of the Columbia Plateau as having reached a "geographic climax" under present-day conditions, i.e. that economy or system of economies found adaptable to the world at large and to the natural environment within a given area that will support the largest number of people on the highest standard of living. The earlier periods of cattle raising on the Columbia Plateau were stages in the succession of economies leading to the climax. The pressure of foreign production on the market level is reflected in the region. Any noticeable increase in population would undoubtedly affect the farming system where large acreage is necessary, and, as noted above, with decreasing soil fertility and decreasing yields, any attempt at general farming and dairying seems to indicate shrinking markets rather than expansion. Present conditions suggest a climax that is dependent upon the world market and upon the extent to which wheat production can be maintained by soil improvement, reduction and checking of soil erosion, plant breeding, and the improvement and use of marginal lands if increasing acreage should become desirable. But whatever the future of the Columbia Plateau wheat region may be, man in that area must work out his economic destiny in relation to a low, dry plateau conspicuously surfaced by a deep layer of loess shaped into steep, treeless hills.

[9] *Ibid.*, p. 12.

[10] O. E. Baker: Agricultural Regions of North America: Part XI—The Columbia Plateau Wheat Region, *Econ. Geogr.*, Vol. 9, 1933, pp. 167–197; reference on p. 192.

SNOWDRIFTS AND THE PALOUSE TOPOGRAPHY

W. A. Rockie
U. S. Soil Erosion Service

AGRICULTURE in the Palouse region of the Pacific Northwest presents some radical differences from that in most parts of the country. Farmers attempting to transplant their previous experience to the Palouse have learned with sorrow that they cannot farm here as they did "back east" or "down south." Even as agriculture differs, erosion differs. One peculiar phase of the regional erosion problem is presented here—that of snowdrifting and associated forms of erosion. Recent studies indicate that snowdrifting may have played a more important rôle in the development of the Palouse topography than has been realized.

An aerial view of the Palouse country shows the semblance of ocean waves in a brisk southwest breeze. There are the long windward rise of each swell, the crest, and the trough over and over again; while local choppiness in the shape of knolls breaks the continuity of the parallel ridges and troughs. Or in such a view of the region as is presented in Figure 2 a sand-dune topography is suggested. A more detailed, vertical view of a small area within this region is shown in Figure 3. The cirque-like north and east slopes show in striking contrast with the smoother, longer south and west slopes.[1] The characteristic snowdrifts form on the upper parts of the shadowed leeward slopes.

The usual contour map with a fifty-foot interval, such as that of the Pullman quadrangle, cannot portray the true character of the Palouse topography. With so large an interval the local details of slope variations are lost. This is especially true of the leeward slopes, the steepest parts of which do not generally exceed fifty feet in height. Only if the contour interval is sufficiently small, like the two-foot interval used on the map of the Erosion Experiment Farm near Pullman shown in Figure 1, are the steeper northeasterly slopes evident.

Snowdrifts and Snowdrift Erosion

Snowdrift erosion involves several integral, related, and overlapping processes. Snowfall in this region is usually either accompanied or followed by strong southwesterly winds, which seldom permit the snow to remain long on the exposed windward slopes but instead pile it up on the upper part of the leeward slopes. The low incidence of the winter sun does not favor ablation, and drifts reach

[1] Compare the description by V. R. D. Kirkham, M. M. Johnson, and Donald Holm: Origin of Palouse Hills Topography, *Science*, Vol. 73 (N.S.), 1931, pp. 207–209. In their explanation the authors state that "nivation appears to be the largest single contributing factor."

depths in excess of ten feet on the fallowed areas of the Palouse region. The snow may include a considerable percentage of intermingled soil, sometimes distributed uniformly throughout the drift but usually occurring in separate strata. Hundreds of thousands of tons of soil are thus moved on the Palouse hills each year.

During the occasional warmer periods commonly known as

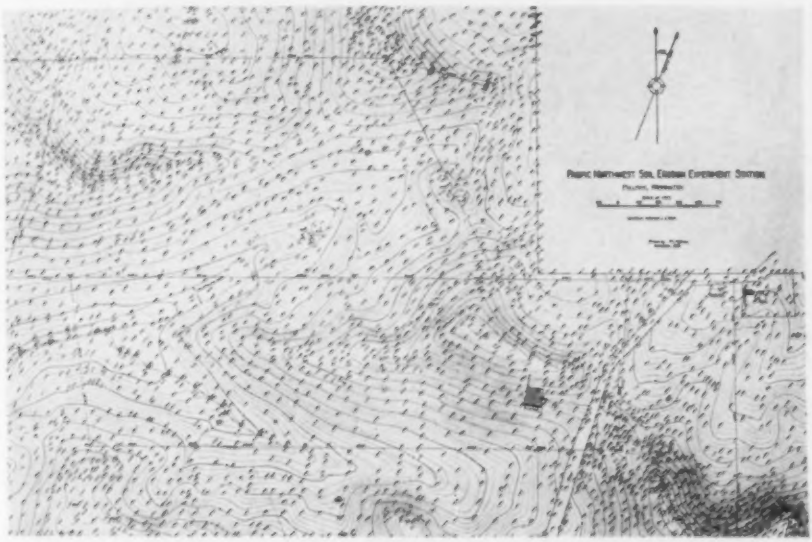

FIG. 1—Detailed contour map of the Pacific Northwest Soil Erosion Experiment Farm near Pullman, Wash., with a two-foot contour interval. Note the contrast between the gentler windward and the steeper leeward slopes. (Photograph by P. C. McGrew, U. S. Department of Agriculture.)

"thaws" or "chinooks" the accumulation of drifted soil-laden snow may be entirely removed. Usually, however, the melting of the drift substantially begins with the break-up at the end of the winter period and may continue for many weeks after the snow mantle has gone from the rest of the land. The break-up is frequently started with a heavy warm rain that causes serious soil washing where the land is bare of snow. The drifts are downslope from the top of the ridge, and the muddy run-off flows out over the white drifts in fantastic, lace-like, shoestring patterns (Fig. 4). The porosity and the absorptive capacity of the surface of the snowdrift at the time determine the distance that this soil-laden run-off remains fluid and flowing. A winter thaw may produce the same effect, with later drifting obliterating all evidence of midwinter overwash.

The soil accumulations on and in the drift itself are, however, of minor account as compared to the wash from the lower edge, due to the enormous quantity of running water released by the drift. Losses from such areas average one to two inches of soil a fallow year.

Careful measurements of the various movements of the soil are

FIG. 2.—Aerial view in the Palouse region, showing Pullman, Wash., in the foreground. In pioneer days Pullman was known as Three Forks because of the confluence of the three forks of the South Palouse drainage in the center of the town. The non-symmetrical, dune like topography is evidenced by individual amphitheaters, generally northeastward. (Photograph by courtesy of 116th Photo Section, Washington National Guard.)

FIG. 2—Aerial view in the Palouse region, showing Pullman, Wash., in the foreground. In pioneer days Pullman was known as Three Forks because of the confluence of the three forks of the South Palouse drainage in the center of the town. The non-symmetrical, dune like topography is evidenced by individual amphitheaters, generally northeastward. (Photograph by courtesy of 116th Photo Section, Washington National Guard.)

FIG. 3—Vertical aerial photograph of the Pacific Northwest Soil Erosion Experiment Station farm and its environs three miles northwest of Pullman, Wash. The fields showing the distinct white strips (trail of straw left behind the combine harvester) are wheat stubble. The strips are 16 feet apart. Experimental vegetative control plots, experimental terraces, and other cultural features are shown. Contour tillage, the general practice in this region, is made necessary by the peculiar Palouse topography (compare Fig 1).

one phase of the investigations that have been carried on at the Pacific Northwest Soil Erosion Experiment Station Farm. Although time and the expense of technical installations have not permitted an exhaustive study, those measurements that have been made, together with repeated observations of the several causative phenomena, offer some hint as to a cause of the peculiar Palouse topography.

FIG. 4

FIG. 5

FIG. 4—Overwash on snowdrift from muddy run-off starting on bare hilltop above the drift. Near Thornton, Wash.

FIG. 5—This photograph (camera pointing downhill) shows the abrupt line between the smooth surface covered by snowdrift in the winter (in the immediate foreground) and the abrupt and terrific concentration of run-off and soil losses from the area below the drift.

The unique climate-latitude-vegetation-soil-relief complex of the Palouse region is probably not duplicated anywhere on the earth's surface. Perhaps this is the reason why the Palouse topography also is unique. Winter precipitation including heavy snowfall, strong prevailing southwesterly winds, the chinook, comparatively low incidence of the winter sun causing retarded melting, the utter absence of tree or brush cover, heavy soil texture, and high relief all appear to be contributory to the erosion complex.

The typical Palouse hill profile is strikingly dune-like: however, in its evolution dune action can be only a secondary factor; the primary cause appears to lie in snowdrift erosion. Figure 6 (left) shows a profile as affected by erosion in the absence of snowdrifts. The amount of erosion by water is directly related to the degree of slope and to variations in soil texture.[2] The winter season in the Palouse region, however, is typically characterized by the snowdrifts that accumulate on the upper part of the head slope of practically all of these leeward hillsides. The drifts entirely stop erosion on the surfaces they occupy, but they cause soil deposition by the two methods already described. Instead of being built up, that part of the slope lying below the drift undergoes destructive change. The melting of the snow at warmer periods during the winter increases or concentrates erosion on the slope below the drift. These actions are diagrammatically shown in Figure 6 (right). The greater erosion immediately below the

[2] H. H. Bennett: The Quantitative Study of Erosion Technique and Some Preliminary Results. *Geogr. Rev.*, Vol. 23, 1933, pp. 423–432.

deepest part of the drift causes a more rapid undermining and recession of that part of the slope and results in a cirque-like outline.

Importance of the Vegetative Cover

Soil movements are enormously increased in the absence or sparseness of a vegetative cover. The practice of summer fallowing, first started in this region 40 years ago, has greatly multiplied the rate of

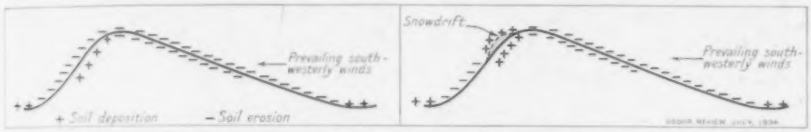

FIG. 6—Soil movements on a typical Palouse hill, without snowdrift (left) and with snowdrift (right). Symbols above and below the profile represent movements due to water and wind respectively. Vertical scale exaggerated twice.

both the undermining and the soil deposition at these snowdrift locations. Observations and measurements over a period of three years indicate that the wind-blown deposits amount to from one-tenth to one-half inch of soil a fallow year. The overwash deposited on the surface of the snowdrift is extremely variable, but it may be several inches in depth. While the top of the slope is being built out every fallow year, the lower portion is being undermined. Definite measurements of this loss have not been made, but an ocular comparison with that of other lands where measurements have been carried out indicates that at least one inch of soil is lost a fallow year. These conditions if long continued can have but one result—increasing steepness and, ultimately, the slipping off of the leeward slopes.

We may assume that the Palouse region was not always covered by the heavy grass mantle that so characterized the area before present cultivation. Whether the Palouse region consists of water-laid sediments[3] or of wind-blown deposits[4] may be immaterial, since there must necessarily have been a long period of time in point of years before the invasion and plant succession that culminated in bunch grass adequately clothed this land. There is also a possibility that a normal dissected topography existed in this area during the Ice Age, when severity of climate might have entirely destroyed the vegetation cover already established over a period of decades or centuries. Some time, then, in the recent geologic past, after the present dendritic drainage had intrenched itself but before the area had developed an ample vegetative cover, these special erosive processes may have helped to produce the characteristic Palouse topography.

[3] R. C. Treasher: Origin of the Loess of the Palouse Region, Washington, unpublished thesis, Washington State College Library, 1925; abstract in *Science*, Vol. 61 (N.S.), 1925, p. 469.

[4] F. C. Calkins: Geology and Water Resources of a Portion of East-Central Washington, *U. S. Geol. Survey Water-Supply Paper No. 118*, 1905, pp. 45–49; C. Van Duyne and others, *Soils Bur. Advance Sheets, U. S. Dept. of Agric.*, 1921.

PRESENT STATUS OF SETTLEMENT IN HOKKAIDO*

Darrell H. Davis
University of Minnesota

JAPAN was formerly divided into several "natural" districts, named from the main national or natural highways to or through them; thus, "Tôkai-dô" (Eastern Sea Way), "Tôsan-dô" (Eastern Mountain Way), "Hokuriku-dô" (Northern Land Way), "Nankai-dô" (Southern Sea Way), and "Hokukai-dô" (Northern Sea Way). The present spelling, "Hokkaido," thus represents the preservation of an old name.[1] And an appropriate name it is, too. Hokkaido is still the "Northland" to the Japanese, a land of long, cold winters, even though the earlier erroneous beliefs as to the extreme rigor of the climate, which long was a factor retarding settlement, have been discredited.

Hokkaido at present exhibits all stages of occupance, from that of the pioneer along the more recently constructed rail lines to established communities with a settled system of agriculture. It is seldom that the stages of sequent occupance can be compared so effectively in such a small area. The earliest Japanese settlement in Hokkaido was on the west coast of the Hakodate peninsula. Early in the nineteenth century Fukuyama, with its feudal lord and a castle the remains of which still exist in a good state of preservation, was a considerable settlement, and Otaru was an important fishing village with a population of about 2000 by 1850. By 1869 the total Japanese population had risen to 22,303 families, or 105,108 persons. Until 1869 Hokkaido was commonly known as Ezo or Yezo; with the establishment of the colonial government in that year the name Hokkaido came into common use.

As the earliest occupation of Hokkaido was based on the fisheries, a large fraction of the population was migratory, as is the condition today in Karafuto. The desire to establish permanent settlement prompted the encouragement of occupation by liberal land grants, particularly to soldiers or "militia men," during 1875 and subsequent years to insure outposts against Russian advance. Traces of this semimilitary occupation still remain in the "militia houses," a characteristic house type in certain areas easily accessible from the sea or from the earlier rail lines, as in the Asahigawa basin.

*A study based on field work in 1932 supported in part by the Fluid Research Funds of the University of Minnesota.

[1] Since there is no other administrative district in Japan with the name "Dô," which translated literally means "way" or "road," the Hokkaido is meant when "the Dô" is mentioned, and the designations "the Hokkaido" and "the Dô" are in interchangeable and common use by Japanese to designate the most northern of the four main islands of the empire.

Railroads and the Spread of Population

The more recent occupation of the arable land has been induced by the building of railroads, agriculture rapidly following rail construction. The first railroad in Hokkaido was built between 1880 and

FIG. 1—Map of Hokkaido showing the three main agricultural regions into which the island may be divided and the development of the railroads. The chief towns are also shown and the administrative subdivisions, *shichos:* subdivision of the *shicho* in *muras* is shown in the following maps, Figures 2 to 7. Scale approximately 1 : 5,000,000.

1885 from Otaru to Sapporo and in the next five years was extended to serve other parts of the Ishikari plain, the largest single plains area in Hokkaido. The construction of these lines brought in a flood of settlers and caused a great growth in the population of Sapporo, the seat of the provincial government. The period 1890 to 1900 witnessed the extension of the rails to Asahigawa and both north and south from that city, to serve the series of intermontane basins lying between the two main north and south mountain ranges of Hokkaido. The rapid influx of population continued into the now available agricultural land, much of which was topographically suited to rice production. Asahigawa, occupying a key situation in the intermontane valleys, became the fourth largest urban center in Hokkaido. Muroran was made the seaboard terminus for a line to Sapporo and an outlet for the coalfields.

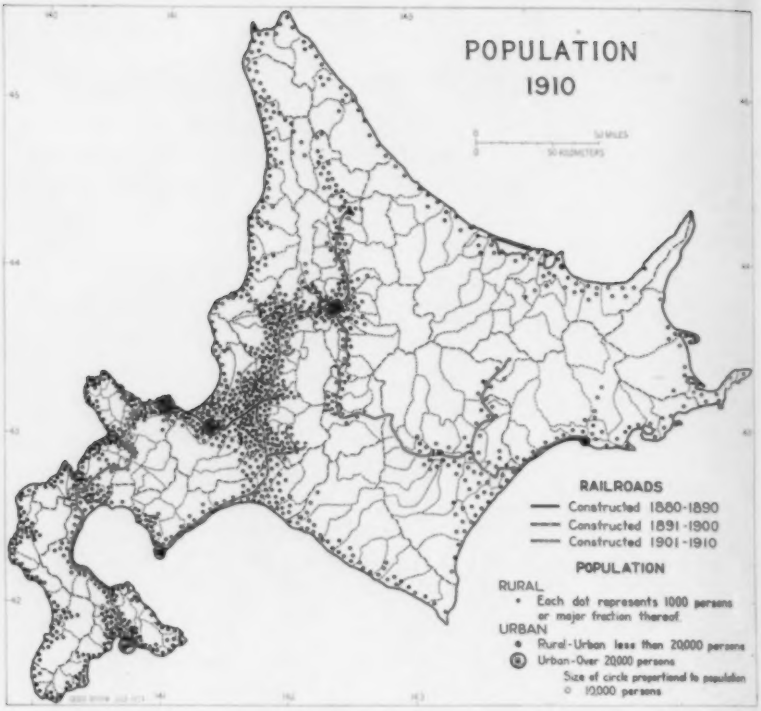

FIG. 2—Population, 1910, localized by *mura* and occupied part of mura.

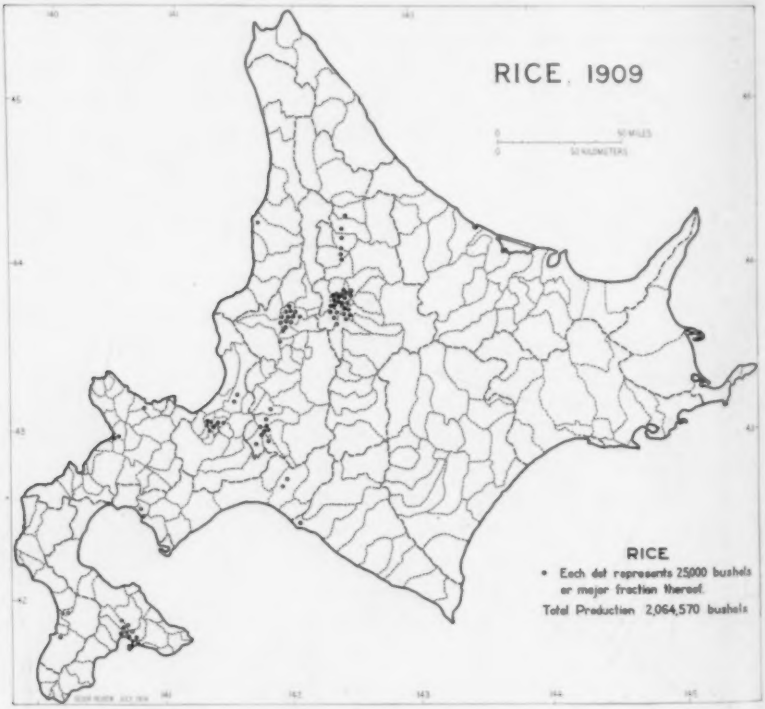

FIG. 3—Rice production, 1909, localized by *shicho* and by rice-producing part of *shicho*.

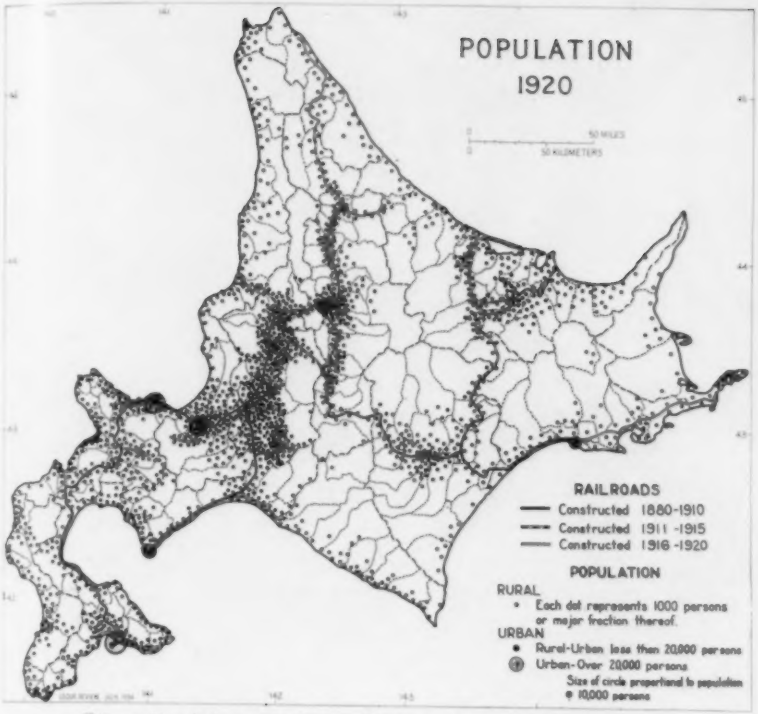

FIG. 4—Population, 1920, localized by *mura* and occupied part of *mura*.

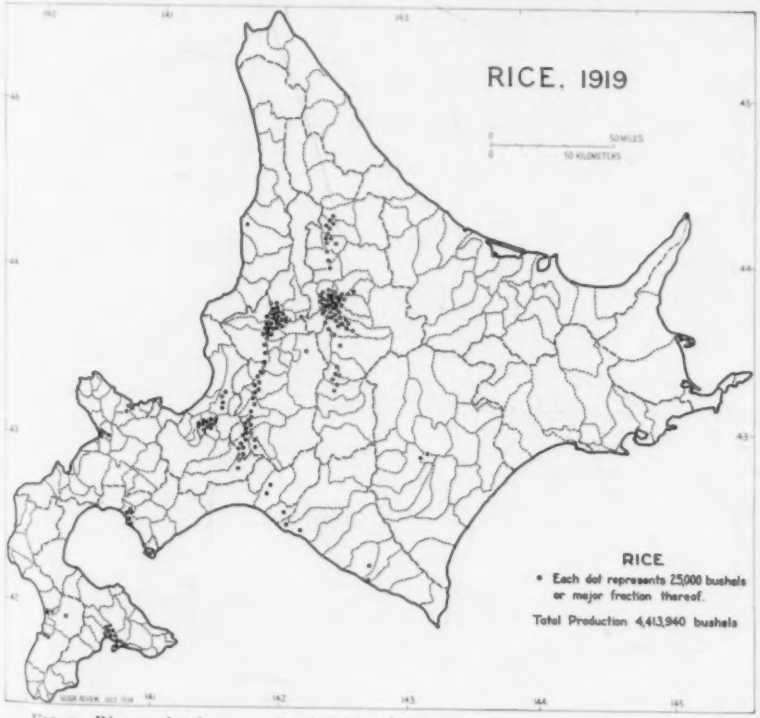

FIG. 5—Rice production, 1919, localized by *shicho* and by rice-producing part of *shicho*.

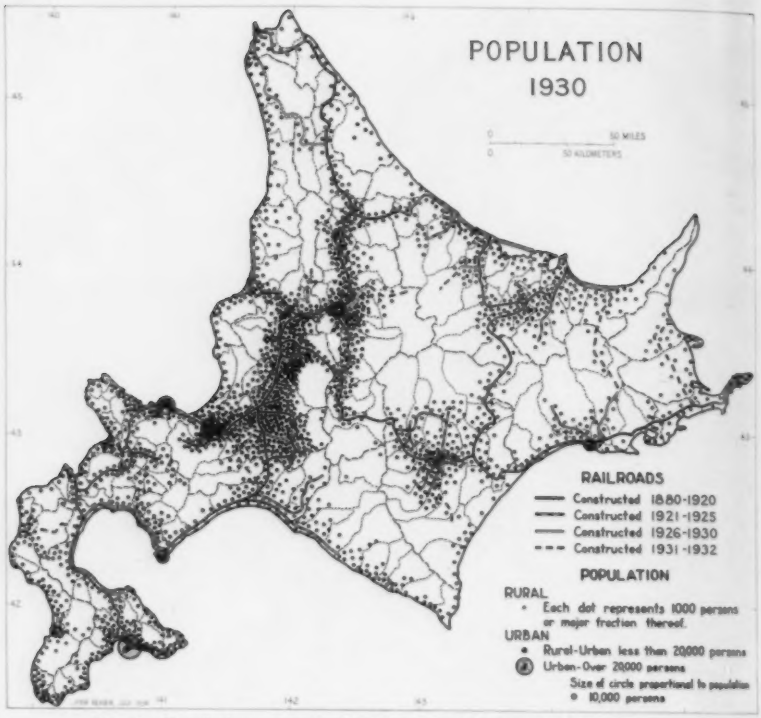

FIG. 6—Population, 1930, localized by *mura* and occupied part of *mura*.

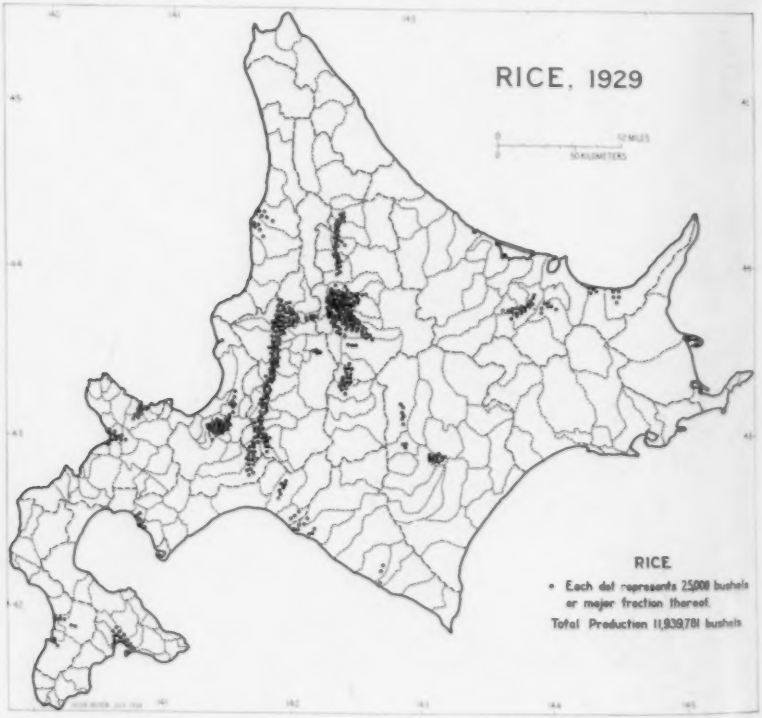

FIG. 7—Rice production, 1929, localized by *shicho* and by rice-producing part of *shicho*.

FIG. 8—Graph showing the acreage of the principal crops in Hokkaido by *shichos*.

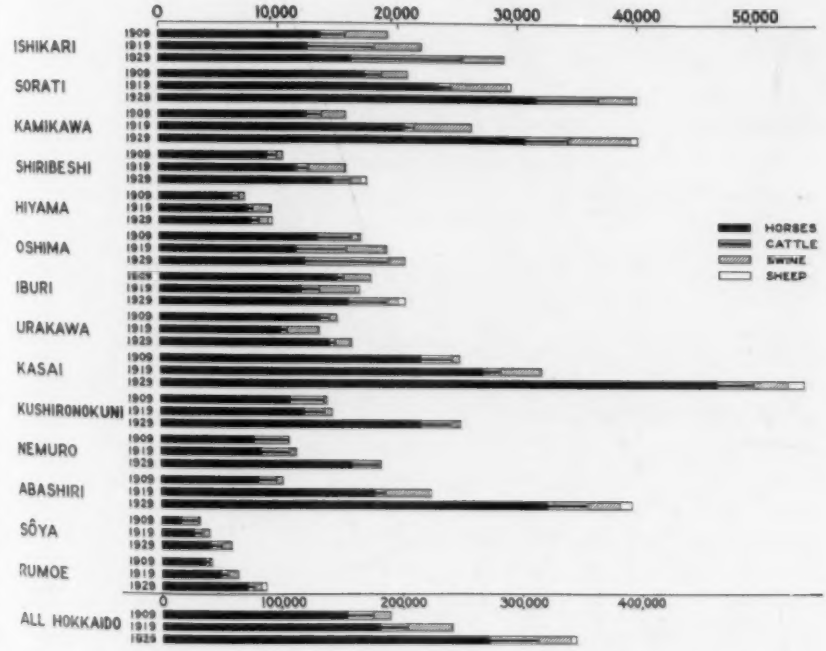

FIG. 9—Graph showing the numbers of livestock in Hokkaido by *shichos*.

By 1910 the southward extension of the line from Asahigawa through the intermontane valleys had been linked with a line to Obihiro, on the Tokachi plain, and eastward to Kushiro, and a short spur extended northward from Obihiro toward Nokeushi. Between 1910 and 1930 the rail lines were extended materially, and population expanded correspondingly. At the present date all the important agricultural areas have been opened for settlement and few potential agricultural areas are more than five miles from a railroad, though the construction of considerable additional mileage is contemplated.

These stages of settlement are reflected in the cultural landscape. The area south of Shari, for example, opened for settlement by rail construction begun in 1929, is still in the first stages of pioneer development. Lumbering operations are in active progress, and the cut-over land is in the process of passing into cultivation wherever such use is feasible. By contrast, on the Ishikari plain near Sapporo, one of the areas of early settlement, the forest is all gone, and all the level land is in productive agricultural use.

The Agricultural Basis for Occupance

Even in Hokkaido the characteristic Japanese agricultural economy centering around the production of rice is in evidence. The arable area of Hokkaido does not exceed 14 per cent of the total land surface; much of it is topographically unsuited to rice production, and all of it has a rigorous climate that would apparently preclude rice as a staple—yet the most important cereal crop in Hokkaido in acreage, volume of production, and call on the land is rice. Even in the vicinity of Nokeushi, where snow may lie on the ground until late in April, rice is an important and often a major crop locally.

This northward extension of the rice-producing area has been made possible by the perfection of varieties that will mature in as short a frost-free season as 90 days. To produce kinds of rice that can be grown profitably in practically all parts of Hokkaido where topography, soils, and water supply make production feasible is a truly great achievement in plant breeding. Furthermore, despite the hazards of unseasonable frosts and occasional crop losses from prolonged droughts, rice production on land suitable for rice is, according to the experience of the agricultural experiment stations, more profitable than the production of other crops on this land. Practically all the peaty soils of the alluvial areas now in agricultural use are in rice.

Much of the area of Hokkaido suitable for agricultural use is, however, upland, topographically unsuited for irrigation and with no irrigation water available except at prohibitive expense. In consequence there is more diversification of agriculture than is general in the southern islands.

FIG. 10

FIG. 11

FIG. 12

FIG. 10—Frontier agricultural conditions near Kami-Sattsuru. The many stumps in the fields and the newness of the buildings are evidence of the recency of occupation. April 22, 1932.

FIG. 11—Rice paddies with stumps in a newly occupied area at Ainonai, four miles west of Nokeushi. The upland in the background is all cleared and in agricultural use. April 21, 1932.

FIG. 12—The Ishikari plain, four miles east of Sapporo, showing a later stage of settlement. Rice paddies on the lowland; dairy farm in the distance on the upland; mountains barely visible in the distance. April 17, 1932.

FIG. 13—Irrigation ditch, rice paddies, and farmhouses in an important rice-producing region in Ishikari. The conical mountain is Mt. Asahidake, 7515 feet. April 19, 1932.

THE CULTURAL LANDSCAPE

In the more recently occupied areas upland farming and upland crops, rather than rice, dominate the landscape. Buckwheat is everywhere a new-land crop, tending to be displaced as agriculture ages. Rice production in an important way, both for newly developed areas and for Hokkaido as a whole, occurs only after settlement has been established for some time, as it is easier to bring the uplands into production than to prepare the peaty soils and worked-over volcanic ash of the alluvial plains for growing rice and to construct ditches to divert water for irrigating the crop.

On the basis of all crops three major agricultural regions in Hokkaido may be recognized (for map see Fig. 1):

FIG. 14—House of thatch construction in the Asahigawa basin, an important rice-producing area. Rice straw piled in the paddies; irrigation ditch and highway April 19, 1932.

FIG. 15—Farmstead with silos, four miles southeast of Sapporo on the Ishikari plain. April 17, 1932.

1. The western, or "Rice and Oats Region." In this area rice is the most important crop, occupying from 20 to 60 per cent of the cropped area, with oats of almost equal importance. Other important crops occupying from 6 to 20 per cent of the cultivated land are beans and potatoes.

2. The northern, or "Mixed Farming Region." In this subdivision rice occupies 25 per cent or less of the cropped land and oats are of about equal areal importance. Beans, potatoes, peas, rye, wheat, and some buckwheat are all important crops occupying approximately equal acreages.

3. The southern, or "Stock Raising Region." In most parts of this area there is but little crop production. The principal crops are oats, beans, potatoes, buckwheat, and peas; rice is produced in

FIG. 16—Farmstead on the edge of the upland north of Ainonai, about four miles west of Nokeushi. House in the background; stable and typical Hokkaido sled at the right; flax piled at the left. April 21, 1932.

FIG. 17—Street scene, Nayoro. Japanese inn on the corner at the left; note the piles of snow in the street. April 20, 1932.

small amounts in the western half. This area embraces an important horse-breeding region.

Farmhouses are generally separated and located on the individual farms. Though farms are not large, they have about four times the area of those in the southern islands; and even if fields are small, as they are in the rice-growing districts particularly, landholdings are not fragmented as in the south. Nor is there a defense need for compact settlements in this recently occupied land. The general effect of the distribution of farm buildings somewhat resembles that of an agricultural area of similar topographic characteristics in the United States.

Indeed, from some distance in certain circumstances one may almost imagine oneself in an American agricultural community.

FIG. 18—Main street of Sapporo. Typical Hokkaido cart and omnipresent bicycles. April 18, 1932.

especially in upland areas where crops such as oats, wheat, barley, beans, hay, and potatoes occupy the fields and where stock raising is important. The farm buildings with gambrel-roofed barns and silos, if not inspected too closely, will strengthen the impression. This is one of the minor results of the fact that American advisers were employed by the Japanese government to suggest the best methods to be used in opening up the new lands of Hokkaido to incoming settlers. But, though all the experimental and demonstration farms show American influences in physical layout, equipment, and practices, the effect of their teachings has not as yet penetrated far or deeply. In most places the farm buildings are extremely crude in construction and represent the preservation of more or less temporary shelters erected by the newcomers.

In few places do the farm buildings represent such a substantial fraction of the total farm value as that in the southern islands. Their generally neglected and shabby appearance should, however, not lead to the inference that agriculture is necessarily unprofitable, since poor buildings in Hokkaido are commonly present on successful farms as success is measured by Japanese standards.

The first sight of buildings apparently so much like American farmhouses and barns might lead to the conclusion that the long cold winters had been taken into consideration. On closer examination, however, it is apparent that the resemblance is in line only. These apparently American-type structures, unplastered, uninsulated, and flimsy in construction, may be less suitable than are those of thatch and mud. The resemblance that such houses bear to farm buildings in this country is superficial only, even to the shingles on the roofs!

The Towns

Except the two inland cities, Sapporo (168,575) and Asahigawa (82,514), and the ports of Hakodate (197,252), Otaru (114,884), Muroran (55,857), and Kushiro (51,584), which owe their importance to the fact that they are the seaboard termini for important rail lines, the towns of Hokkaido are of the urban-rural type—country market towns of small importance. A Hokkaido town of 20,000 is not similar, as regards general appearance, function, or type of development, to an American population aggregation of the same size. For example, Nayoro is of about this size, but a street scene in the urban core reveals many striking differences. Such small centers have no factory industries that serve as a basis for support of their populations. Some opportunity exists here for the expansion of industry to supply the demands of local markets, in addition to the possibility of some further development of the more important factory industries, pulp and paper manufacture, mining, and smelting.

The Prospects

Such is the condition of Hokkaido today, after it has served for 50 years or more as a field for immigration, one of the outlets for the surplus population of the southern islands. From 58,000 in 1869, the population mounted decade by decade: 191,172 in 1880; 321,118 in 1890; 786,211 in 1900; 1,609,546 in 1910; 2,359,183 in 1920; 2,812,342 in 1930. Steady increase in population has been general in all *shichos* except Shiribeshi and Sôya. Of these two, Sôya is only in part on the main island and depends almost entirely on the fisheries; Shiribeshi is one of the earlier settled areas and, like Sôya, depends largely on the fisheries.

The newness of the area is seen in the composition of the population, males exceeding females by the ratio of 109.5 to 100. Furthermore, the productive portion of the population (ages 15 to 60) is 55 per cent, which is above the average for Japan and results from the absence of the age groups above 60—a characteristic of a young area.

Now, however, virtually all the good agricultural land is in use. Immigration is already decreasing. From an average of 77,000 persons a year between 1916 and 1920 the number of incoming settlers fell to an average of 28,000 a year for the five-year period ending in 1925. For the five-year period ending in 1930 an average of 26,000 a year is a reasonable estimate. There was a distinct drop in 1932 and in 1933; in the latter year the figure probably did not exceed 22,000. Natural increases are already beginning to more than equal immigration in the more densely populated and more promising rice and oats region, and the same will be true elsewhere within a few years. Population densities in the purely agricultural areas can never equal those of southern Japan, as only one crop a year can be produced on a given field. The center of population, which has been advancing steadily in an easterly direction for many years, has begun to shift south-southwest as immigration into the less promising agricultural areas of the east and northeast has been offset by biologic increases in the more densely populated regions of the west, such as the Ishikari plain and the Asahigawa basin. This shift is also in part a result of actual emigration—some 2000 persons left the Nokeushi district in 1931.

The Hokkaido government estimates that the Dô, when fully occupied agriculturally and developed industrially and commercially, will support a total population of 6,000,000 people. This estimate is based on a density comparable to that of the southern islands and assumes the possibility of a similar industrial and commercial development. This would mean an agricultural population of about 3,000,000 and an urban, or industrial and commercial, population of equal numbers—an optimistic estimate! The present agricultural population is about 2,000,000; the present urban population, 800,000. To

expand agriculture to support 3,000,000 people and by the use of submarginal land to afford part-time employment in connection with the forest industries may be possible; to increase the urban population from 800,000 to 3,000,000 is probably impossible. Even on the assumption that such an expansion should occur, Hokkaido could care for only about three years' increase of Japan's population at its present rate.

The Ainu

A word may be said about the aboriginal inhabitants, the Ainu. They are estimated to number about 16,000 individuals, distributed approximately as follows: 6000 in Urakawa; 3100 in Iburi; 1500 in Kasai; 1000 in Kushironokuni; with the balance in many much smaller, widely scattered groups. Poor hygienic conditions in crowded settlements, insufficient nutrition, and the increased use of intoxicating liquor have had the same effect on them as on other primitive races: the Ainu population is virtually stationary, with a tendency toward actual decrease in numbers. Furthermore, in dress, customs, and language the Ainu is tending to lose individuality, especially in areas where Japanese occupation has been of long standing.

For the past ten years or more the Ainu have been agitating for the abolition of the Ainu Protective Law and the restoration of some of the land that originally belonged to them, but it is improbable that any allocation could be arranged that would be satisfactory to both Ainu and Japanese. However, with the disappearance of the barriers of custom and language, intermarriage with the Japanese will occur even more commonly than at present, so that in Hokkaido, as has already occurred in Honshu, the Ainu will disappear as a distinct element of the population.

NOTES ON A PHYSIOGRAPHIC DIAGRAM OF JAPAN*

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[With separate map, Pl. II, facing p. 402]

COMPLEXITY and fineness of pattern are the keynote of the surface configuration of Japan. Even within small areas there is often the greatest diversity in earth materials, their structures, and the land forms resulting. Lofty folded ranges forming the axis of the archipelago have been altered by block movements so that faulted and folded forms are intermingled. Peneplain remnants at relatively high altitudes are widespread throughout the country, contrasting curiously with the steep slopes and high relief. Repeated volcanic eruptions and intrusions, extensive and widespread, have added further complications. Moreover, none of these tectonic forces are at present quiescent; on the contrary, their current activity is conspicuously evident in the recurring showers of volcanic ash, outpourings of lava, numerous earthquakes, and changing strand lines. Short streams of steep gradient, acting upon these complex structures and materials, have sculptured a land surface whose lineaments are varied and intricate.

A thick core of moderately rugged hill and mountain land, containing numerous tectonic depressions with a narrow and discontinuous perimeter of terraces and less elevated delta fans—such is the gross pattern. Roughly 75 per cent of the area is hill or mountain country in which slopes are usually too steep and soils too thin for normal cultivation. As a result of recent and rapid uplift, with associated vigorous erosion, the rounded land forms and deep regolith cover typical of mature climatic landscapes in the rainy subtropics are not predominant except where granite weathers to rounded cupola features. Fault and flexure scarps are conspicuous and commonly serve as boundary lines between the geomorphological subdivisions. Scores of volcanic cones, in various stages of activity and dissection, accounting for some of the highest elevations of the archipelago, together with their associated lava and ash plateaus, are both widespread and strikingly prominent. The widespread Tertiary sediments are geographically significant, first, because they are the sources of much of Japan's mineral wealth, more especially coal, and, second, because

*The map was prepared by Guy-Harold Smith in collaboration with the author. It will appear in a monograph entitled "A Reconnaissance Geography of Japan" to be published in 1934 in the *University of Wisconsin Studies in the Social Sciences and History*. Fieldwork in Japan was subsidized by the John Simon Guggenheim Memorial Foundation, the University of Wisconsin, and the National Research Council.

certain series of the Tertiary are weak and poorly consolidated, forming characteristically low, thoroughly dissected hill country of moderate slopes and considerable valley-floor area.

The mountain streams, short, swift, shallow, and, in general, unnavigable, are principally significant as sources of hydro-electric power and irrigation water for the populated plains. Detritus-choked tectonic basins, their floors a series of terrace levels, and, along their margins, coarse-textured alluvial cones, often forming irregular piedmont zones, are characteristic of large parts of the Japanese mountain lands.

The plains, none of them extensive, are almost exclusively surfaces of aggradation. There are no extensive structural plains underlain by undisturbed strata and covered with residual soils. The typical plain of Japan is a small isolated patch of riverine and wave-worked sediments developed in a coastal indentation or a mountain basin. The largest is the Kwanto, or Tokyo, Plain, roughly 2500 square miles in area. Lowlands are predominantly peripheral. Seldom is the alluvium continuous along the coast for any distance, owing to frequent interruption by hills and mountains as they come down to the ocean's margins. To the eye most of the delta fans are essentially flat, but this impression is seen to be erroneous when one beholds the relatively strong flow of water in the rivers and the irrigation canals. The streams on the lowlands are for much of the year shallow and braided, flowing in extraordinarily broad, boulder and gravel-filled channels, flanked on either side by natural and man-built levees. They are of little use for navigation, but their elevated beds make gravity irrigation a simple matter. The seaward margins of the alluvial lands, especially where they front upon the open ocean, are commonly bordered by beach ridges, the outer ones capped with dunes. These littoral features of beach ridges and dunes are especially well developed on the Japan Sea plains of northern Honshu where the full force of the winter-monsoon gales is felt.

The inner margins of the delta plains often terminate abruptly at the bases of the encircling foothills. Where rivers debouch on a plain, the transition is made less abrupt by coarse-textured alluvial fans, sometimes completing a piedmont belt. In other places the descent from mountain to plain is broken by intermediate steps in the form of sand and gravel terraces, remnants of uplifted ancient coastal plains, or delta fans designated as diluvium (shown on the diagram by more open stipple) in contradistinction to the more recent alluvial deposits (closer stipple of the physiographic diagram). Less frequently these benches are wave-cut platforms covered only with a veneer of gravel and sand. The diluvial terraces are conspicuous features in Japan because of their distinctive form, extensive area, and widespread distribution. The fact that they are found in almost

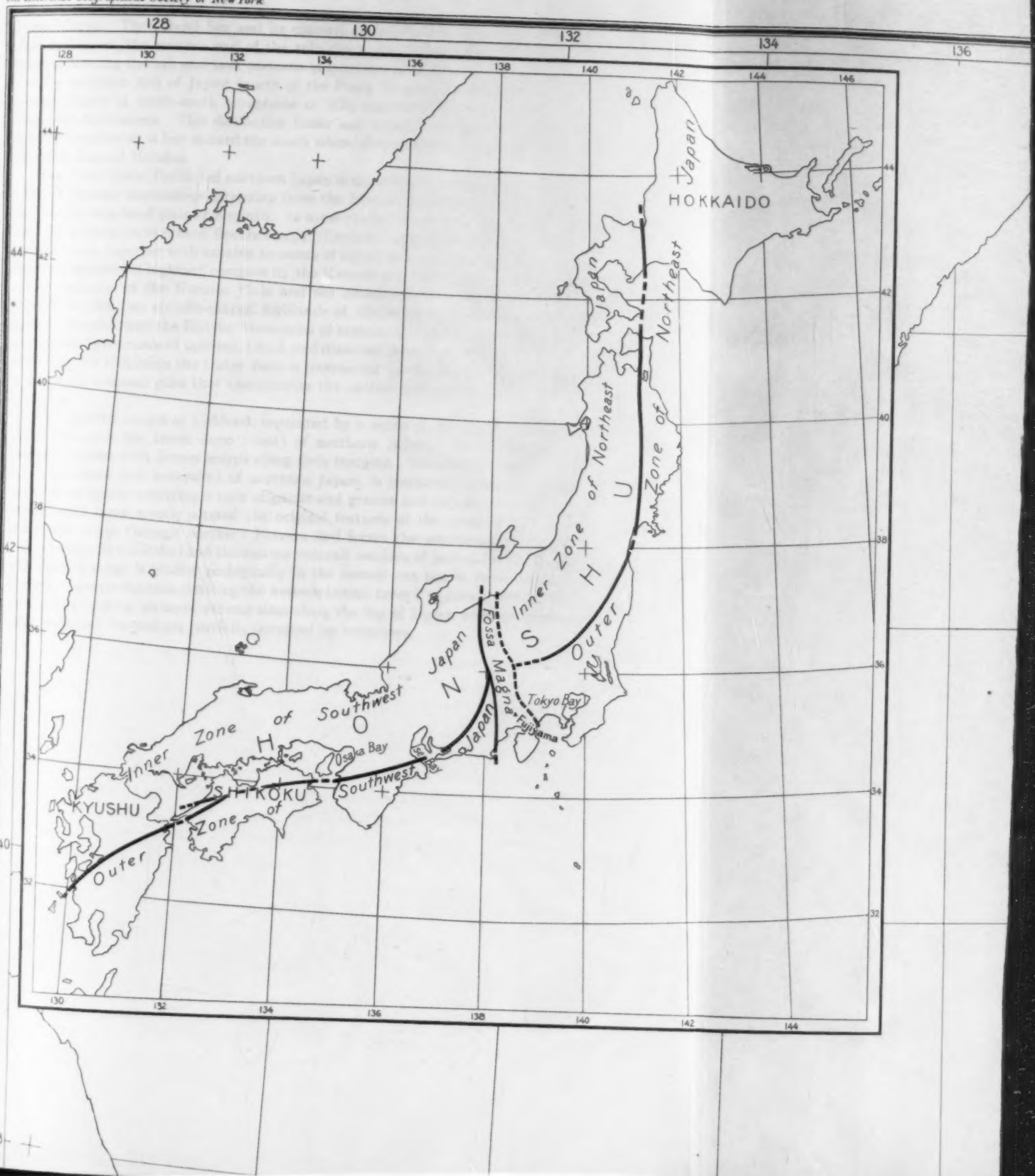
all parts of the country from Hokkaido to Kyushu has led one group of geomorphologists to infer rather general and contemporaneous uplift of the entire archipelago. Usually the terraces form low upland platforms standing out several scores or even hundreds of feet above the adjacent new alluvium. Vertical downcutting by streams is rapid in these unconsolidated fluvial sediments, the resulting terrain characteristically exhibiting shallow, canyon-like valleys with flat to gently sloping interstream uplands. The latter feature is often a remnant of the original depositional surface, the relatively smooth sky lines of the terraces being a distinguishing characteristic of their profiles when seen from a distance.

Four Geomorphological Zones

The inset map in the physiographic diagram shows the four zones into which the country may be subdivided. The "Outer" and "Inner" zones are parallel zones of contrasting geological structure. Fault scarps and tectonic depressions mark their contact except in the mountain knot of central Honshu where the arrangement of the principal features is confused and complicated. Further subdivision is made by the great zone of subsidence, the Fossa Magna. It appears as though the mountain arc were bent back along this fracture and the rift subsequently filled, in part at least, by younger strata and volcanic piles. A series of local structural basins lie at the bases of the fault scarps. Along this depressed zone runs the Fuji volcanic chain.

The southwestern Outer Zone, designated as the Pacific Folded Mountains, is separated from the Inner Zone by a line of great dislocation, with which are associated several graben valleys and a conspicuous fault scarp, extending from central Honshu through the Kii peninsula and northern Shikoku to western Kyushu. The Pacific Folded Mountains are characterized by well developed longitudinal ridges and valleys in parallel arrangement, trending northeast-southwest, each formation separated from the other by longitudinal dislocation lines. They are generally high and rugged and contain few plains of conspicuous size. The predominant rocks are crystalline schists and older sedimentaries greatly folded and contorted. Minerals, of which copper is most important, are largely of the bedded replacement type. In central Honshu this Outer Zone is represented by the high Akaishi Mountains, terminating on the east in a bold fault scarp overlooking the Fossa Magna. Declining gradually in elevation, the Pacific Folded Mountains are continued westward in the southern parts of the Kii peninsula, Shikoku, and Kyushu, submarine subsidence basins isolating them into separate mountain masses. In southern Kyushu the Outer Zone is intersected by the Ryukyu or Luchu Arc, resulting in a southern appendage of volcanic materials consisting of an ash plateau, volcanic cones, and lava flows.

In contrast with the Outer Zone, the Inner Zone of southwestern Japan is a series of dissected block plateaus, mostly rugged hill country, though genuinely mountainous in parts. Granite is abundant, so that rounded forms and slopes covered with a whitish crust of weathered rock are more typical here than they are in any other subdivision of Japan. The geological structure and physiographic history are extremely complex. Ancient sedimentary rocks pierced by granitic intrusives have been peneplaned, cut by a complicated system of fault lines, some of the resulting blocks suffering upheaval and others depression. Throughout most of the area fault-block structures with associated tectonic valleys and basins are common. Volcanic activity is relatively widespread. The highest elevations are in central Honshu where the Hida Range (Japanese Alps), with some peaks exceeding 3000 meters, terminates abruptly at the tremendous fault scarp overlooking the


HOKKAIDO
Japan
Zone of Northeast
Japan
Inner Zone of Northeast
Japan
Outer
Fossa Magna
Tokyo Bay
Fujiyama
Inner Zone of Southwest
Japan
Osaka Bay
Outer Zone of Southwest
Japan
SHIKOKU
KYUSHU
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PHYSIOGRAPHIC DIAGRAM OF
JAPAN
BY GUY-HAROLD SMITH
1933
SCALE
0 50 100 150 200 MILES
0 100 200 KM
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A. Hoen & Co., Lith.

Fossa Magna. The Inland Sea and its channel outlets to the open ocean occupy depressed zones, the western end of the subsidence area being filled with volcanic material forming the ash and lava plateaus of northern Kyushu.

The northern half of Japan (north of the Fossa Magna) is composed of three parallel chains of north-south mountains or hills separated from one another by structural depressions. This distinctive linear and parallel arrangement of ranges and depressed zones is lost toward the south where they coalesce to form the central mountain knot of Honshu.

The Outer Zone (Pacific) of northern Japan is separated from the Inner Zone by a line of tectonic depressions extending from the Ishikari-Yufutsu lowland in Hokkaido to the bay-head plain of Kwanto. In some places this series of depressions has fault-scarp margins; in others, flexure scarps. Gneisses, crystalline schists, and older sedimentaries, together with notable amounts of intrusives, are characteristic. Five separate segments of highland compose it: the Kwanto and Ashio blocks, forming the western margins of the Kwanto Plain and not conspicuously separated from the Inner Zone; the two spindle-shaped highlands of Abukuma and Kitakami farther north in Honshu; and the Hidaka Mountains of eastern Hokkaido. In general they all have the appearance of uplifted, tilted, and dissected peneplains with complicated structure. In Hokkaido the Outer Zone is intersected by the Kurile Arc, resulting in the great volcanic piles that characterize the central and eastern parts of that island.

Two parallel ranges of highland, separated by a series of detritus-floored fault basins, compose the Inner Zone (west) of northern Japan. The highlands are elongated domes with flexure scarps along their margins. The central range, which is the backbone and watershed of northern Japan, is composed chiefly of recent sedimentary strata overlying a core of gneiss and granite and capped with volcanic cones, which have greatly altered the original features of the mountain. It is a continuous range through northern Honshu and forms the northernmost knob of Mutsu peninsula (Honshu) and the eastern volcanic sections of peninsular Hokkaido. The western range is similar geologically to the central one but is more varied in altitude. Several streams, draining the western basins, cross it in antecedent valleys, their deltas forming plains of various sizes along the Sea of Japan, some of them in caldron-shaped depressions partially occupied by volcanoes.

JAPANESE CITIES

DISTRIBUTION AND MORPHOLOGY*

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THROUGHOUT the greater part of its history Japan has been emphatically a rural nation. Even at the close of the nineteenth century, when the total population had reached 44,000,000, there were only 78 urban communities whose populations exceeded 20,000. The next quarter of a century, however, saw an accelerated industrial and commercial expansion with a concomitant urban growth, so that by 1925 there were 217 cities containing over 20,000 people, their combined populations totaling nearly 28 per cent of the country's 59,000,000 inhabitants. While total population increased 34 per cent, the number of cities increased 178 per cent—Japan was rapidly becoming more urban. But even at the present time about 54 per cent of Nippon's citizens are agriculturists and the commonest unit of settlement is the agricultural town of 2000–10,000 dwellers, 57 per cent of the population residing in such agglomerations.

ORIGINS

It was not until the latter part of the Middle Ages, with the establishment of a feudal system of society and the division of Japan into fiefs ruled over by local sovereigns, or daimyos, that conditions became propitious for the development of cities. The castle of the daimyo surrounded by the quarters of a large group of professional warriors, the samurai, was the attractive center. It offered at least three advantages: a strategic market; a degree of protection in a period when internecine warfare was a scourge; and opportunities for amusement and entertainment. Thus most of the first large towns and cities had their origin as strategic political-economic centers of small semi-independent feudal empires. Artisans and traders flocked to these daimyo cities, and in a number of instances a center became so specialized in some feature of trade or manufacture as to acquire national fame. So firmly established did these specializations become that certain ones have persisted even to the present time. Takekoshi[1] in his recent work on the economic history of Japan indicates three additional types of city origin in feudal Nippon: (1) temple or shrine

*The fieldwork in Japan in 1926–1927 and in the summer of 1932 was made possible by a generous subsidy from the John Simon Guggenheim Memorial Foundation and research grants from the National Research Council and the University of Wisconsin. A full report of the author's work will appear as a monograph entitled "A Reconnaissance Geography of Japan," to be published in 1934 in the *University of Wisconsin Studies in the Social Sciences and History*.

[1] Yosoburo Takekoshi: The Economic Aspects of the History of the Civilization of Japan, 3 vols., New York, 1930; reference in Vol. 1, pp. 243–245 and 358.

cities to which merchants and traders were attracted by the market advantages offered by the thousands of worshippers visiting certain famous religious centers; (2) post stations critically located along important highways and also offering peculiar market advantages (many of these post stations, however, were combined castle towns and hostelry centers such as, for instance, Shizuoka, on the famous Tōkaidō highway); (3) the free ports, which were not under the control of any lord or group of priests but were ruled exclusively by the merchants who inhabited them.

I have no exact data by which a precise comparison can be made of the number of cities having one or more of these four origins. Certain it is, however, that the castle cities greatly outnumbered the others. When Shogun Hideyoshi's land survey was made in the last decade of the sixteenth century, there were 160 fiefs, each with its own lord and capital city. At the time the Tokugawa shoguns were establishing their capital at Yedo (Tokyo) a quarter of a century later there were 197 feudal lords, all except two of them having definite fiefs. Eight great Shinto shrines and eight similarly important Buddhist temples were also recognized by the Tokugawa shogunate, but the combined revenues of these, plus those of the numerous others scattered throughout the provinces, were less than 2 per cent of those of the feudal lords.[2] The number of free ports also was never large, the total being only 10 in the year 1500.[3]

At first the castle was a simple frame house surrounded by turf-covered earthen embankments in the form of steps or terraces, protected and made more durable by wooden piles. It was not until after the introduction of European firearms that radical departures from this simple type of structure were made. Under Portuguese direction the first castle having European earmarks was constructed in 1575. It was at this time that heavy flared walls of cut stone, usually andesite or granite, pierced by several protected gates, began to supplant earthen terraces or embankments, and encircling moats were added as a further item of defense. The residence itself, however, still remained simple and Japanese in type.[4] These extensive wall and moat-protected grounds, in size and massiveness quite out of proportion with other Japanese structures, were, and still are, conspicuous features in the drab and crowded cities. They have been the cores around which accretion has taken place. Today the grounds of these feudal relics are most commonly occupied by military barracks or schools, and they provide an environment in which both children and soldiers may absorb the spirit of Japan's romantic past when

[2] Takekoshi, *op. cit.*, Vol. 1, pp. 418–421 and 527–534.

[3] *Ibid.*, p. 373.

[4] See Ludwig Mecking: Japanische Stadtlandschaften, *in* Stadtlandschaften der Erde, herausgegeben von Siegfried Passarge, Hamburg, 1930, pp. 109–123. The author desires to acknowledge his free use of this source.

daimyo princes and their samurai warriors ruled Nippon. Few, if any, of the original residences remain, as fires have razed the wooden structures repeatedly. Usually the daimyo's castle occupied some sort of elevation such as a hard-rock outlier or diluvial spur—a type of site that made it doubly conspicuous and more easily protected. It was never very far removed from the low alluvial plain, however, for the encircling moats must be filled with water, and this was usually possible only where the ground water was near the surface. Moreover, nearness to the seacoast was considered of some importance since in time of war it made more certain an uninterrupted supply of salt, manufactured from the sea water. A characteristic feature of the castle town was the offsets in the streets, causing numerous angles and jogs—a part of the defense plan.

In spite of the fact that the last half century has seen a remarkable growth in urban population, it appears that relatively few large cities actually have been called into existence by the exigencies of the modern era. Chief among these cities are the great deep-water ports of Kobe and Yokohama, the new urban centers of semifrontier Hokkaido, and the industrial port cities of northern Kyushu. Others, like Osaka, Nagoya, and Sakai, ancient in origin and fame, have been greatly expanded and altered during this era of industrial and commercial revolution.

Distribution and Location

Of the 107 cities in Japan with populations of 25,000 or more in 1930, only six are in Hokkaido, the northern island, and 15 in Ou, that part of Honshu north of about 37° N., while 86, or 80 per cent, are in old subtropical Japan south of 37°. This latitudinal distribution, with increasing density of total population, and even more emphatically of cities, toward the south, reflects not only the unsuitability of Japanese ways of living to the more severe northern climates but also an increasing distance from ancient and modern political and economic centers. The Japanese houses, methods of heating, diet, crop specialization, and clothing are all better adjusted to humid, subtropical conditions. Moreover, it is in the south that Japan's national history began and has principally flourished. Her ancient and hallowed capitals and the modern one as well are all south of the 37th parallel. A deeply indented coast line providing numerous natural harbors, and, at the heads of the largest tectonic bays, some of the greatest aggradational plains of the country—these too are more typical of southwestern Japan. Hokkaido is still the frontier, and even northern Honshu is looked upon as peripheral, somewhat removed from the nation's core, and possessed of a climatic environment that imposes hardships upon its inhabitants.

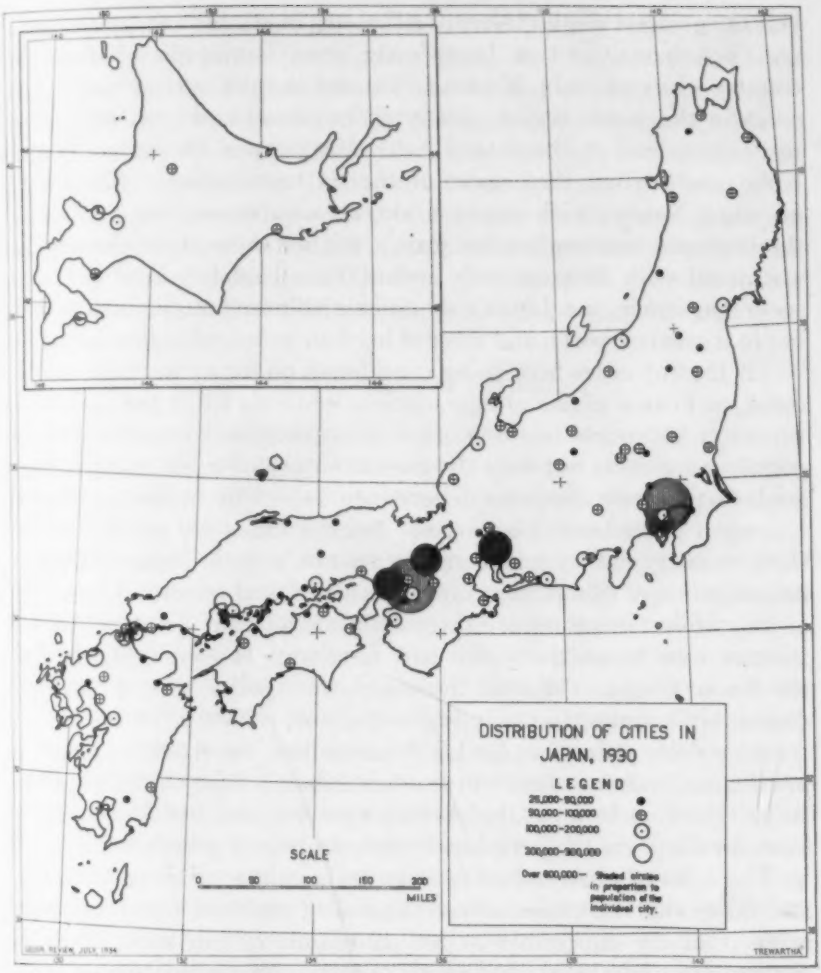


FIG. 1—Japan's cities are concentrated on littoral plains (compare the Physiographic Diagram of Japan, facing p. 402). The three greatest nodes of city concentration are on the relatively large Tokyo, Nobi, and Kinki plains—all of them aggradational in origin—which have collected in the quiet waters at the heads of tectonic bays. The population of Tokyo, which was slightly more than 2,000,000 in 1930, has been increased to more than 5,000,000 by the inclusion (October 1932) of much peripheral territory within the city limits.

Within that part of Old Japan south of 37° N. there is a marked concentration of cities within a much elongated industrial belt lying between Kwanto on the north and northern Kyushu on the south. This includes northern Kyushu, the Inland Sea borderlands, and the Pacific littoral from the eastern end of the Inland Sea to Kwanto. Of the 86 cities with over 25,000 people included within subtropical Japan south of Ou, 69, or 64 per cent of the nation's total, are within this belt. This concentration is not associated with any one particular advantage but more especially with historical antecedents and with easy accessibility by water. Within this much elongated urbanized

belt the greatest single cluster of cities—13 in all, and including Tokyo and Yokohama, two of Japan's six great metropolises—is on the country's largest plain, Kwanto. Second in rank is the cluster of 11 cities in the Kinki region occupying bay-head and graben plains at the eastern end of the Inland Sea. Within this cluster are Osaka, Kobe, and Kyoto, three more of the six metropolises. Nine cities, including Nagoya with nearly 1,000,000 inhabitants, are grouped on the lowlands surrounding Ise Bay. Within these three clusters, all associated with deep tectonic indentations and bay-head plains of some magnitude, are Japan's six cities with over 600,000 inhabitants, her four greatest ports, and three of her four principal industrial nodes.

Of the 107 cities here being considered, 90, or 84 per cent, are located on littoral plains of aggradation, while 60 to 70 per cent have tidewater locations (see Fig. 1). This peripheral concentration of population reflects not only the coastal nature of most Japanese lowlands but likewise the great dependence, especially in the prerailroad era, upon water-borne commerce. Interior cities are relatively few. Only 17 are genuinely inland and located on interior basins that have no sea frontage. Six of these are in the meridional tectonic depressions of Ou, while four more are in local basins of that great transverse fracture zone across the widest part of central Honshu designated as the Fossa Magna. Most of these are strategically located on intercoastal land routes, formerly highways, now railways. A number of those on delta plains, but back a distance from the coast, are situated at advantageous locations where rivers debouch from the hilly hinterland. Mecking believes the predominant fish and rice diet to be at least one factor in the peripheral concentration of population.

The sites of most urban centers are portions of these same low alluvial or diluvial plains where flatness of site and squat buildings make it nearly impossible to get panoramic or bird's-eye views of settlements. Of the 21 cities with over 100,000 population in 1925, all were nearly exclusively on flattish coastal-plain sites. Like many of the rural settlements, some of the smaller cities occupy slightly elevated dry sites, such as river terraces or beach ridges, on the wet delta plains. In contrast with conditions along the Mediterranean and Cornish coasts, where picturesque towns cling to the sides of declivities, Japanese settlements characteristically occupy flattish sites, and only a few like Nagasaki, Hakodate, and Kobe spread up the slopes. A number of cities, including Tokyo and Yokohama, occupy two levels, the flattish tops of the diluvial terraces and the lower alluvial and coastal plains.

Morphology

From the viewpoint of cultural morphology two large groups of Japanese cities may be distinguished. The first comprises the six great

metropolises, or "national cities"—Tokyo, Osaka, Nagoya, Kobe, Kyoto, and Yokohama—with more than local hinterlands, whose populations are each in excess of 600,000, and on which there is a definite foreign imprint, especially throughout the business and industrial sections. In contrast with these stand the scores of other cities that are essentially Japanese in their features and to a considerable degree appear to be cast in the same mold. A great gap or unconformity separates the six metropolises from the several score smaller cities, as there are only three of these with populations of over 200,000 and none at all in the 300,000 or 400,000 or 500,000 groups.

The Indigenous Cities

With minor modifications, the indigenous Japanese city of 25,000 to 250,000 people has many landscape features in common with the over 8000 smaller agricultural towns. To be sure, their populations comprise fewer farm families, but taken as a group they are characteristically local business centers and ports, almost invariably on a railroad, and serve a restricted tributary area much as they did during the feudal period. Mecking comments on their functional similarity to the towns of feudal Germany. Not only the occupied sites, but the sky lines as well, are flattish. There is a dead levelness about the sea of somber, slate-colored tile roofs and unpainted frame buildings that is absent in even small American cities. Water towers, church spires, and tall substantial buildings of brick and stone are lacking. Trees are largely absent. The color supplied by the painted residences or the building materials in an American city is missed: the flimsy, unpainted, weather-stained Japanese structures are totally lacking in color. Two features are often conspicuous because their height or mass sets them apart from the general monotony of sky line: one is the daimyo's castle, with its extensive wall and moat-encircled grounds containing trees; the other, the shrines and temples, the latter gaily painted.[5]

A prevailingly rectangular grid of streets, often with a north-south, east-west orientation, characterized many of the early cities and is still a common feature of the old cores of many modern ones (see Fig. 2). Two explanations may be offered for this arrangement. Certainly the low, flattish delta sites of most of these cities make such a grid arrangement feasible. This influence of the site is verified by the fact that where Japanese cities are on slopes the rectangular grid disappears or is modified. The other explanation invokes Chinese influence, for that people, who had produced the grid of Imperial Peking, made a very marked imprint upon things Japanese, including the cities. Imperial Kyoto and Nara are excellent examples of this

[5] Ludwig Mecking: Kult und Landschaft in Japan, *Geogr. Anzeiger*, Vol. 30, 1929, pp. 137–146.

Chinese influence. The rural highways, however, often neither are straight nor do they follow the cardinal directions; hence, as the city expands and encroaches upon what were agricultural areas, the street system built upon the original rural highway skeleton frequently loses the grid pattern and becomes confused. Thus there are numerous instances where the old core of a Japanese city is rectangular in street arrangement while its newer, and often peripheral, sections are not—the reverse of conditions prevalent in many old American and European cities. The numerous and recurrent disastrous fires common to Japanese settlements have been a factor permitting frequent and widespread alterations of the original city plans. These changes are often revolutionary in their rapidity rather than of the usual slow evolutionary type of process. As an example, witness the drastic changes now in progress at Tokyo and Yokohama as a result of the earthquake and fire of 1923. Chronic fires as well as the universal habit of building in wood account for the almost total lack of ancient buildings.[6]

Streets are prevailingly narrow. Invariably they are surfaced with stone, but they are seldom smooth, and paving is rare. Low, closely spaced, unpainted structures, often built flush with the street, line both sides. There are no sidewalks and no lawns. Open gutters carrying drainage or refuse water from the houses parallel both sides of the street, immediately in front of the dwellings. In most of the smaller Japanese cities a distinct downtown business section is not nearly so evident as in most American cities. Many, if not actually most, of the streets combine both residential and commercial functions, for the dwelling and the shop are one, the shop occupying the street side, the family living in the back or in the second-story rooms. Sliding doors allow the whole front of the little shop to be entirely open to the street so that all its wares are conspicuous to the passers-by. Each shop usually specializes in a single type of product. A few semi-foreign-style buildings are to be seen, but they are always isolated and never form solid blocks. In exclusively residential sections each house is surrounded by a high and forbidding wooden or stone wall, so that such streets are quite without interest.

Composed as they are of small one-family houses, all much alike and closely spaced, often abutting against one another, it would appear on first thought that Japanese cities should occupy much less space than those of similar population in the Occident. This may be true of smaller urban centers, but the prevalence of multifamily apartment houses in European and American cities of over 50,000 probably corrects the discrepancy, in a measure at least. So uniform

[6] The general prevalence of conflagrations is due in large part to the closely spaced, flimsy wood-and-paper buildings as well as to the universal use of open fires for heating and cooking. Until recently, paper lanterns with candles were the common form of illumination. In parts of the country fires are associated with earthquakes.

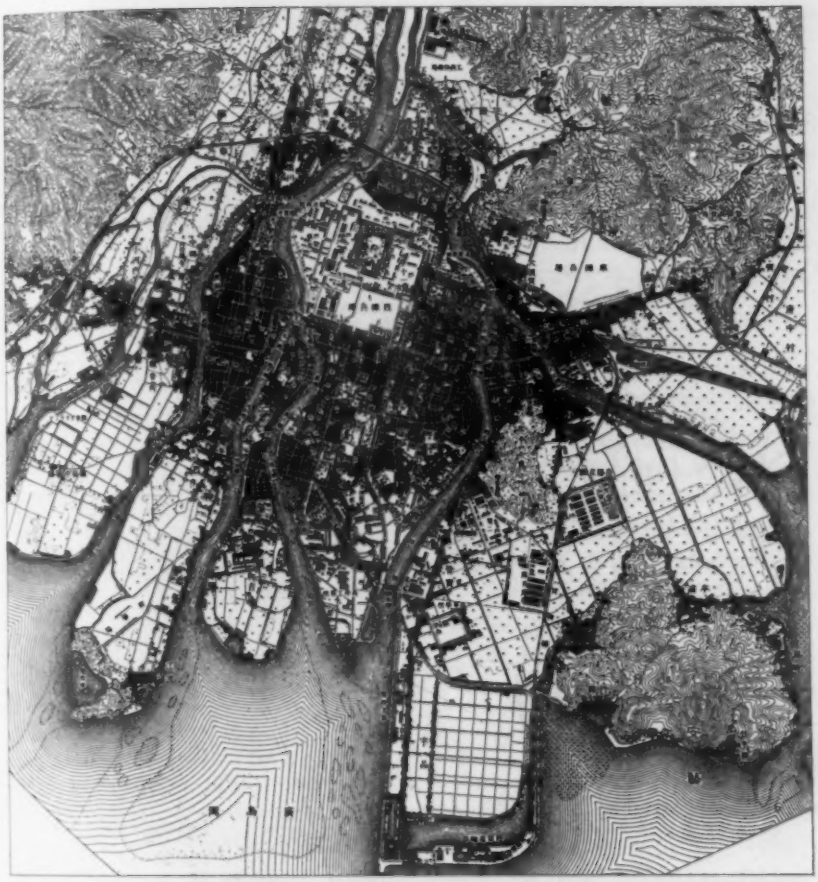


FIG. 2—A representative Japanese city: Hiroshima (270,000 population) on the shores of the Inland Sea. It occupies a flat delta site and is intersected by numerous distributaries and canals. Its core, around which accretion has taken place, is the daimyo castle grounds, shown on the map by the relatively open space in the north-central part of the city. In the older part of the city, near the castle, there is a well developed grid of streets, while in the peripheral sections right-angled intersections are not so common. Reduced from Japanese Topographic Map, on the scale of 1 : 25,000: this scale approximately 1 : 62,500.

in size, spacing, and number of occupants are Japanese houses that it is said to be possible to calculate accurately the population of a city by knowing its dimensions.

Because of their delta locations, rivers and canals are common and conspicuous features of urban landscapes. They are arteries both of trade and commerce and of waste disposal. Factories, warehouses, and heavy retail establishments tend to congregate along their margins largely because of the cheap transport services that they offer for bulky goods, as lighters and sculled barges can bring wares from little tidewater ports to the very doors of the warehouses. The canals are usually not attractive because of both the kinds of establishments

that border them and the refuse that they carry. As a corollary of the network of canals and rivers characteristic of so many Japanese cities, bridges are unusually numerous.

The Six Metropolises[7]

The six great metropolitan centers of Japan, each with more than 600,000 inhabitants, as distinguished from the group just described, are the only ones that have much more than a local sphere of influence. Their distinctive landscapes are the result, not of any new Japanese element, but rather of more complete westernization of their business, transportation, and manufacturing features. It is in the "downtown" retail business core that the stamp of foreign influence is most in evidence. Here there are solid blocks of large, substantial buildings, European in appearance, built of brick, stone, and reënforced concrete. Nevertheless, the larger parts of their areas are still distinctly Japanese in aspect, with flimsy oriental structures combining the functions of retail shops and residences and fronting on unpaved thoroughfares. Narrow streets are still the rule, although in all six of the large cities widening and paving of a number of the business thoroughfares have been accomplished, and in Tokyo and Yokohama ambitious new city plans are being executed. Traffic composition is most cosmopolitan, numerous taxis, motor busses, and tram cars contrasting with the slow human and animal-drawn carts and the ubiquitous bicycle.

FIG. 3—Residential Tokyo for the most part occupies a dissected diluvial terrace, while the business and industrial sections of the city are at a lower level on the recent alluvial and coastal sediments. From Tokyo City Planning Map, in "Tokyo, Capital of Japan, Reconstruction Work, 1930," published by Tokyo Municipal Office.

[7] The best treatment of the five tidewater cities is to be found in Ludwig Mecking: Japan's Häfen, *Mitt. Geogr. Gesell. in Hamburg*, Vol. 42, 1931. Reviewed in this number of the *Geographical Review*.

All six of Japan's great cities are on or near some of the largest of the country's alluvial plains that have collected in the quiet waters at the head of long tectonic bays (map facing p. 402). Each plain is a major focus of settlement that provides an important populous local hinterland. Only one, Kyoto, does not have tidewater location. Four of them compose the nation's quartet of greatest foreign-trade ports, while the fifth, Tokyo, although not an "open-port," is outstanding in domestic water-borne commerce. All are important rail centers as well. These same six cities are focuses of manufacturing within the three greatest industrial nodes of the country and so, with one exception, combine port and manufacturing functions.

Based upon two items, location and function, these six cities may be divided into three groups: (1) The three largest centers, Osaka, Tokyo, and Nagoya, each located at the head of its respective bay on the sea margins of advancing delta plains, are the business, industrial, and consuming centers of their large local hinterlands. (2) Kobe and Yokohama, the deep-water ports of the adjacent Osaka and Tokyo consuming and industrial nodes, are located 15 to 20 miles down their respective bays where silting is not marked. The Nagoya Plain at the head of Ise Bay has no representative in this port group. (3) Kyoto, the single representative of the third group, is an inland city, its principal fame accruing as a result of its having been the nation's capital for over 1000 years.

From a regional point of view, as shown by the previous analysis, four of Japan's great cities arrange themselves into two binuclear conurbations, the corresponding units in each pair having many locational, site, and functional characteristics in common. On Tokyo Bay are the twin cities of Tokyo-Yokohama, part of a conurbation whose total population is close to 6,000,000 and a part also of Japan's largest settlement unit (11,000,000 people), which is coincident with the country's largest plain (Kwanto). Tokyo, much the larger member of this couplet and the political and industrial center, is not a foreign-trade port, although on tidewater and served by boats, as the waters at the head of the bay are too shallow for deep-draft vessels. Yokohama, 18 miles down the bay, on deeper water, not only acts as Tokyo's port but is the principal ocean gateway for all of northern Japan. It is a new city, having been brought into existence after the opening of Japan to foreign trade in 1858.

Not only in location and function but likewise in morphology are the two great Kwanto cities in contrast. Tokyo is not only much larger but also more compact. The moat and wall-enclosed Imperial Castle, of feudal architecture, located on a terrace spur overlooking the lowland and bay, is the core around which accretion has taken place, so that even today it is near the geographical center of the modern city and is the focal center of a cobweb pattern of urban trans-

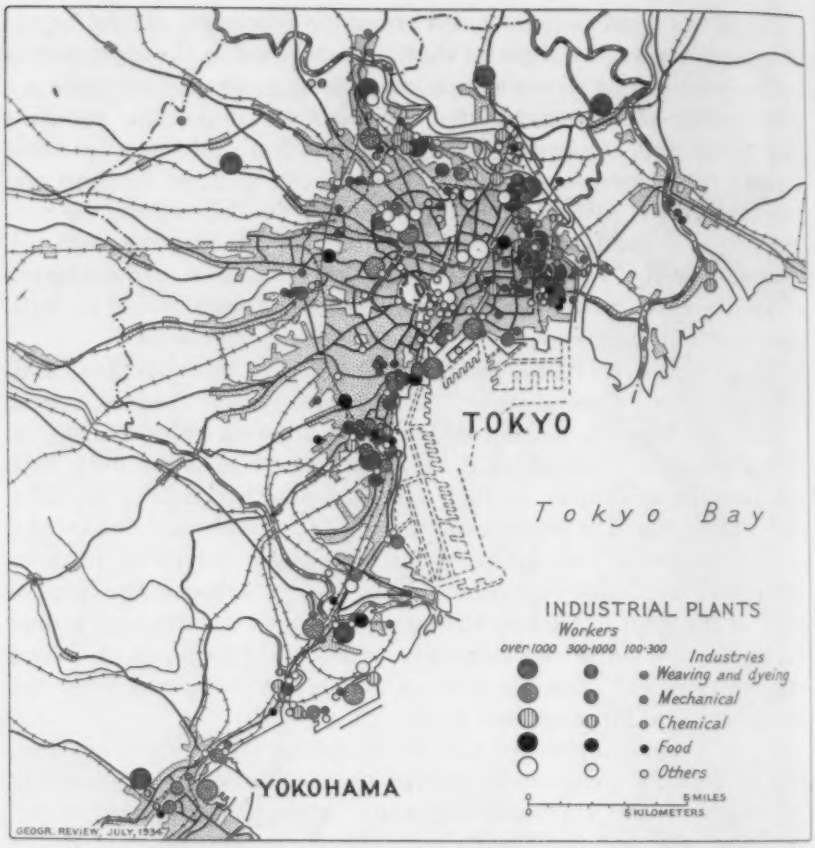


FIG. 4—The distribution of industrial plants in the Tokyo Bay cities. Built-up areas are shown in light stipple. Redrawn in black-and-white from the excellent Japanese atlas, "The Newest Atlas of Japan," Tokyo, 1929.

port lines. Even beyond the city limits these radial highways localize urban development in the form of modified *strassendorf* settlements, so that octopus form is conspicuous. The capital of Nippon occupies two contrasting sites: the manufacturing and commercial parts of the city are on low flood-plain and delta sediments, where rivers and canals are very numerous, while western Tokyo, largely residential, occupies the crests and dissected margins of a terrace some twenty to forty meters high. It was the commercial-industrial section of the city located on the flood plain that was razed by the earthquake and fire of 1923, and it is this part that is being reconstructed on a modern scale with wide thoroughfares and many fireproof structures. The business core of Tokyo has numerous foreign-style buildings. Two distinct manufacturing sections are conspicuous, one along the principal waterway and its branches, the other extending southward along the bay toward Yokohama.

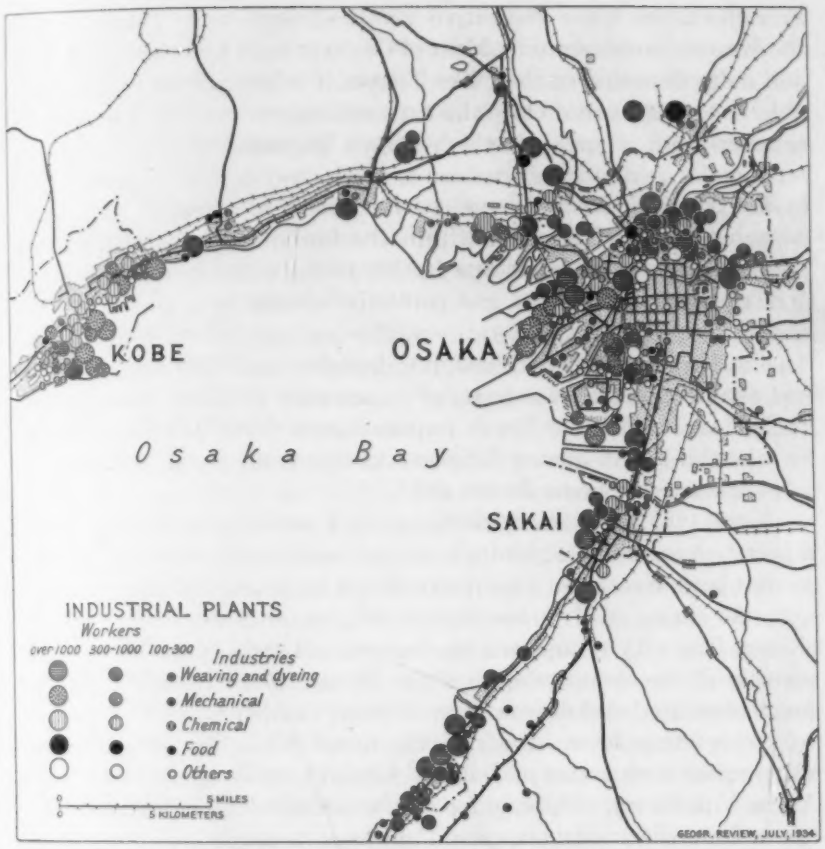


FIG. 5—The distribution of industrial plants in the Osaka Bay cities. Built-up areas are shown in light stipple. Redrawn from "The Newest Atlas of Japan," Tokyo, 1929.

Yokohama (620,000), the second port of Japan, has no such spread as Greater Tokyo, having less than one-eighth as many inhabitants;[8] nor is it as compact. Here the bluffs approach close to the sea, so that extensive flood plains and large silting rivers are lacking. The core of the city completely occupies a small wedge of alluvium between diluvial uplands, but the settlement has expanded northward along the coastal strip and up on the crests of the terraces as well. Manufacturing and shipping features occupy the restricted coastal strip along which new land is being reclaimed to permit industrial expansion.

Corresponding to the Tokyo-Yokohama combination are the twin cities of Osaka-Kobe, on Osaka Bay—Osaka, the metropolis, industrial city, and consuming center, on the delta, with Kobe, its deep-water port, 16 miles down the bay. Osaka (2,454,000) as the industrial unit of the conurbation and Kobe as the deep-water port both surpass

[8] Since October, 1932, Tokyo's population has been increased from 2,000,000+(1930) to 5,312,000 as a result of extension of boundaries and the inclusion of suburban areas. The city of Greater Tokyo now covers 220.23 square miles instead of 31.36 square miles as formerly.

in importance their respective rivals—Tokyo and Yokohama—in the Kwanto combination. Most of Osaka is built upon low flood-plain and delta deposits, so that, like Tokyo, it is intersected by innumerable water channels. Only the extreme eastern margin is on diluvial terrace, upon a spur of which stands imposing Osaka Castle. A rectangular grid of street pattern is much more conspicuous here than in Tokyo. The business core, with its modern occidental buildings, occupies a central location within the lowland city: manufacturing plants dominate the landscape farther to the west. Both the business and the industrial areas are perfectly served by numerous water channels. As in Tokyo, there are no physical restrictions to expansion. The harbor is entirely artificial, but dredging and other improvements now make it possible for boats of 10,000 tons to enter, most of them anchoring at buoys. These improvements have permitted Osaka to take third rank among Nippon's foreign-trade ports, although the large transpacific boats do not call.

Kobe (788,000), like Yokohama, is a new city and emphatically a port.[9] A formidable granite horst here approaches near to the coast, so that large rivers and a correspondingly large alluvial plain are lacking. As silting is of minor importance, water is relatively deep offshore. The city occupies a narrow coastal strip lying between the water and the abrupt slopes of the horst. Even though Kobe is a much elongated and narrow city, its inner residential portions occupy relatively steep lower slopes of the horst, while the industrial and shipping sections are on partially reclaimed land along the water front. As in Yokohama, shipbuilding is the outstanding industry. Kobe has no immediate local hinterland but owes its origin and its continued prosperity to the populous Kinki region adjacent and particularly to industrial Osaka, for which it acts as a deep-water port.

Kyoto (765,000), the third of the triumvirate of great Kinki cities, is the only one of the six without the advantages of water transport. It was the political capital of the empire for nearly eleven centuries, and it still retains its imperial grandeur and beauty. Like Nara, Kyoto is a pilgrimage center, for the environs of the city are classic ground upon which 1500 years of Japanese history have run their course. A charm of refinement, culture, and quietness pervades it. It is scarcely a part of manufactural Japan and may very definitely be classed as a capital and university city. During the feudal period it developed as a handicraft center, and so it is even today. Large factories are excluded. The ancient center of the city is the extensive rectangular grounds of the old Imperial Palace, with its long north-south axis. Around this is the almost perfect rectangular grid of north-south and east-west streets, more strikingly developed in Kyoto

[9] Hyogo Harbor, now included within the boundaries of Kobe City, was of importance during the feudal period.

than in any of the other great cities. Its site is a slightly elevated fan in the northeastern corner of the Yamashiro basin where streams from the surrounding hills debouch on the plain. Kyoto is more distinctly Japanese in its features than any of the other five great cities, although in the commercial nucleus occidental-style structures are common but not dominant.

Political, trade, and industrial center of the Ise Bay settlement unit, containing 4,500,000 people, is the city of Nagoya (907,000). Its original nucleus was a magnificent feudal castle, which, owing to the southward expansion of the city, is now near the northern margin. The settlement's peculiar funnel shape, tapering toward the bay, has resulted from intentional coincidence with a slightly elevated diluvial site only 5 to 15 meters above sea level, and even less above the adjacent wet alluvial plain, where floods are dangerous. The old city core just to the south of the castle grounds has a remarkably rectangular street grid. Because of the diluvial site, low though it is, the canal and river net is much less dense than it is in Osaka and Tokyo. This fact, together with the added handicap of the location of the original city nucleus some four miles from tidewater, and very shallow water at that, greatly restricted modern industrial development. Unlike Tokyo and Osaka, Nagoya has no Yokohama or Kobe to serve as a foreign-trade port; consequently it depends more upon rail service. As a result of recent harbor improvement it is possible, although not easy, for boats of 10,000 tons to enter the harbor, so that within a decade Nagoya has become the nation's fourth port in foreign trade and one of the most rapidly expanding industrial centers of the country.

LAND UTILIZATION MAPS OF KOREA*

John Wesley Coulter and Bernice Bong Hee Kim
University of Hawaii

EIGHTY per cent of the population of Korea are engaged in cultivation of the soil. The accompanying maps, Figures 1 to 8, show in a broad way certain relationships between the distribution of the population and the use of the land. The areas of heavy crop production are also the areas of dense population. By far the larger part of the arable land is devoted to the raising of grain. Rice, most important of the cereals produced, occupies one-third of the acreage and is the food staple. Barley, wheat, and millet have a prominent place among other grains. Soy beans are in high esteem, and radishes also. A considerable area is given over to mulberry trees for sericulture.

Agriculture and the Crop Maps

The similarity of the population and rice-distribution maps is striking. Both express the effect of topography. The rugged relief of northern Korea offers little opportunity for agriculture: the mountain arc that runs southward near the east coast stands out clearly as backbone and watershed, descending steeply to the east and more gently to the west. The effect of climate is less reflected in the picture. The climate of Korea is of a modified continental type, the north distinctly more extreme. Fusan, in South Keisho Province, has mean temperatures of 2.1° C. in January and 25.6° in August; absolute extremes range from 35.3° to −14°. Yuki, in North Kankyo, has January and August means of −9.4° and 21.4° respectively and absolute extremes of 36.4° and −24.3°. Even more pronounced is the continentality of the northern interior. Tyukotin has recorded temperatures of 38° and −41.6°. The northern basins have less rainfall, mean annual precipitation ranging from nearly 150 centimeters around the south coast to 50 centimeters in the Tumen River basin. Most of the rain falls in summer; Fusan, for instance, has nearly four-fifths of its yearly total between April and September inclusive.

Thus, while the average population density of Korea, with its 21 millions (1930), is 227 a square mile, the provinces show a range of from 85 a square mile in rugged North Kankyo to 420 in North Zenra, with its open plains and valleys. South Zenra has 396 a square mile, North Keisho 309, and South Keisho 413. In part this greater

*This study is based on statistics obtained from the office of the Governor-General of Korea (Chosen), published in March, 1932, and from the Annual Report on Administration of Chosen, 1928–1929, and on a visit to Korea in June and early July of 1932. Acknowledgment is made of information furnished by Dr. Hoon K. Lee, Union Christian College, Pyengyang (Heijo).

density in the south is related to the intensive use of the land by double cropping. Twenty-eight per cent of the area of paddy rice is so used, with barley and wheat as the winter crops.

Nearly all the rice is paddy rice. Half of the area of paddy land is watered by rainfall only; the remainder is irrigated. The importance of rice farming in the western half of Korea is in part due to irrigation on the flood plains of many rivers. The growing season for rice ranges from 150 days in southern Korea to 100 days in the north. Planting begins the first week in June in the south and about the last week in that month in the north. Some ten varieties are raised, and the average yield is about 25 bushels an acre.

An increase in the area devoted to rice and a greater yield per acre have been brought about by the encouragement and assistance of the Japanese government, which finds in Korea a convenient granary for helping to feed the large population of the home country. The total amount exported is now more than ten times as much as in 1910.

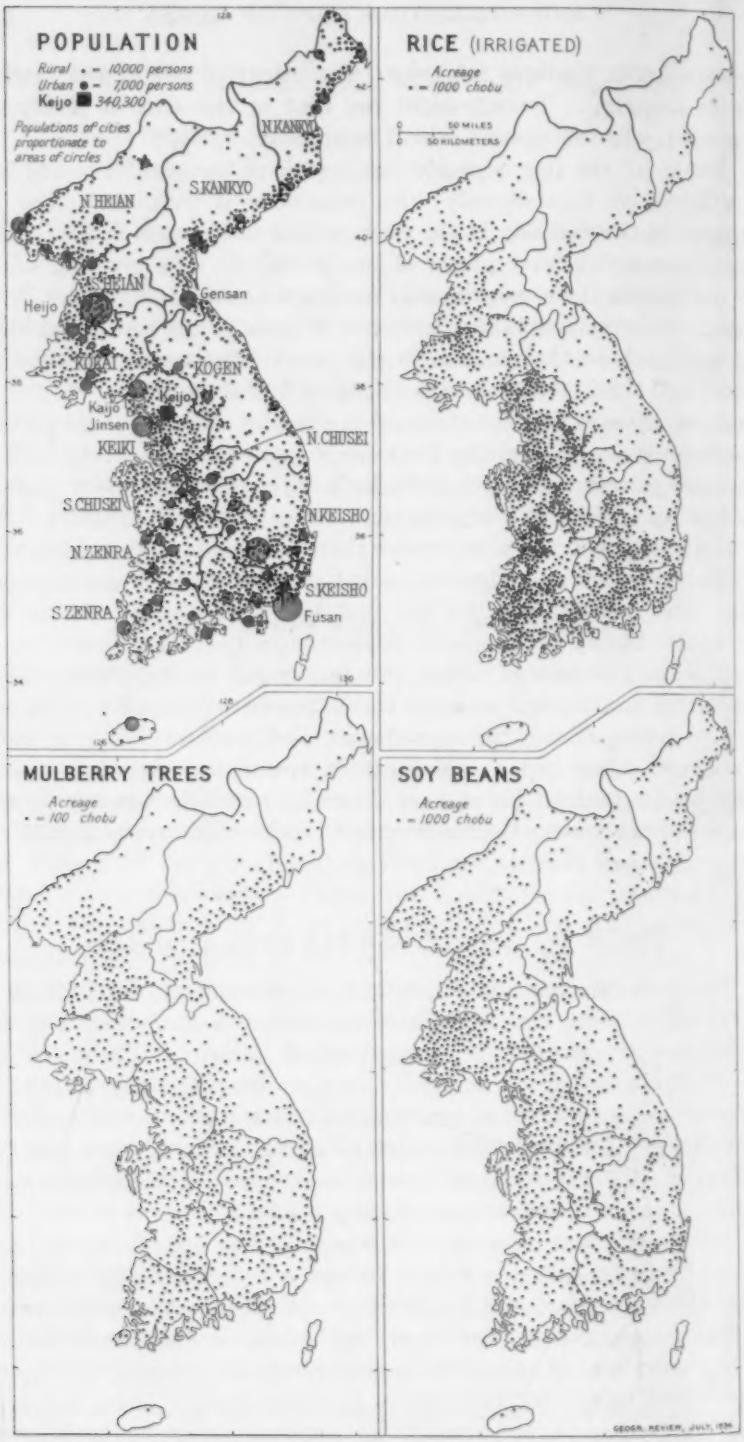
Barley, millet, and wheat are cultivated largely for home consumption. The acreage used for the first two is much larger than that for wheat: barley is especially important in the south, millet in the north. The province of Kokai, in west-central Korea, leads in wheat production and exports an appreciable amount to Japan proper.

The raising of soy beans, radishes, and mulberry trees is widely distributed. Soy beans rank next to rice as an article of export. Radishes are popular for making "kimchi," an indispensable adjunct to the Korean menu. Sericulture is a family industry, generally carried on as a side line.

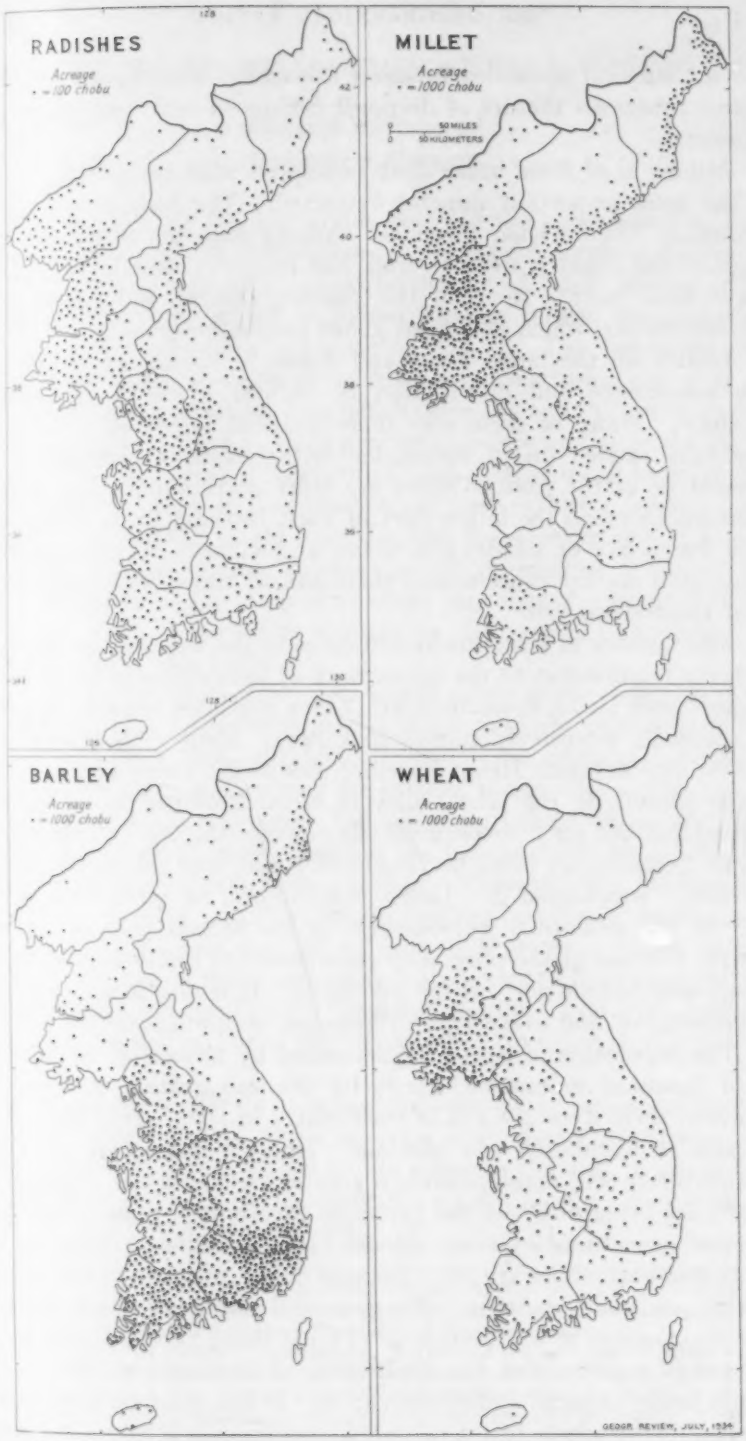
Other Occupations and the Population Map

The fisheries are an important supplement to agriculture in Korea. The south and west coasts are deeply indented, fringed with islands and islets, and have many good harbors. The coast line is long—5400 miles, or nearly twice that length if the islands are included. The tidal range on the west coast is great—ten meters in some places. The peninsula is also a meeting place of warm and cold currents. All these features have a bearing on the fisheries, notable for the abundance and variety of their product.

During the last two decades considerable improvements have been introduced into the fishing industry, especially with regard to types of boats, gear, and methods of operation. The value of the catch, 8,000,000 yen at the time of annexation, increased to 65,000,000 yen in 1929; that of prepared aquatic products increased during the same period from 2,650,000 yen to 44,815,000 yen. Dried fish is an important article of food throughout the peninsula. No little of the recent progress of Korean fishery has been brought about by



FIGS. 1 to 4—Maps of Korea showing the distribution of population and of rice, mulberry trees, and soy beans respectively.



FIGS. 5 to 8—Maps of Korea showing the distribution of radishes, millet, barley, and wheat respectively.

the introduction of skilled Japanese fishermen. They have taught the native fishermen the art of deep-sea fishing—a new venture for the Koreans.

Mining is of little importance compared with agriculture. Gold is the most important mineral extracted. The largest mine is at Unsan, in North Heian Province. Among minerals mined in other parts of the country are coal, iron, and copper. Manufacturing also plays little part. In 1929 the country boasted only some 5000 establishments, which employed about 100,000 people.

Nearly all the larger cities and towns in Korea are centers for the assemblage and distribution of various kinds of agricultural produce. Many of them owe their size and importance partly to activities carried on in connection with affairs of government at present or in the past. Others are chief ports and fishing centers. Koreans carry on the larger part of their internal trade at markets held every five or six days in towns and villages. There are more than 1300 market centers, and their annual transactions amount to over 180,000,000 yen.

The number of large towns and cities in the west and south bears a direct relationship to the importance of agriculture in those parts. From North Heian down to South Zenra populous centers are found in the wide, intensively cultivated valleys. Heijo (Pyengyang), the largest city in South Heian Province, lies in the valley of the Daido. Keijo (Seoul), in the Han Valley in Keiki Province, is the present capital and was for five centuries the capital—the last—of old Korea. Kaijo (Songdo), 45 miles northwest of Keijo, was the capital before the latter supplanted it. Jinsen (Chemulpo), 24 miles west of the seat of the peninsular government, is the second port in Chosen. Fusan, the seat of the provincial government of South Keisho, is the oldest and largest port on the peninsula. It is also a fishing center of importance, and so is Gensan (Wonsan), in South Kankyo.

The population of Korea has increased by more than six millions since Japanese annexation, partly by the immigration of Japanese, of whom there were 488,478 in the country in 1929. It is likely that increase in population will continue. Improvements and expansion in agriculture will make possible a greater yield in crops. Strenuous efforts are being made by the Japanese government to modernize the Korean agricultural system. Model farms have been instituted on which demonstrations are given in grain cultivation, sericulture, horticulture, and stock farming. The principal problem in agriculture is the rejuvenation of worn-out soil. This is being gradually solved by the use of legumes and the application of fertilizer. Untilled land also is being brought under cultivation. It has been estimated that about a million *chobu* (2,450,000 acres), comprising hillsides, marshes, and beaches, can be made productive by terracing and reclamation.

THE UPPER SILESIAN INDUSTRIAL DISTRICT*

Richard Hartshorne
University of Minnesota

STRADDLING the low divide between the valleys of the Oder and the Vistula on the southern margin of the northern European plain is the important industrial district of Upper Silesia. The smaller part of this district, in former Russian Poland, was acquired in 1919 by the reconstructed state of Poland. The remaining and larger part, formerly German or Austrian, constituted the crux of the Upper Silesian question, over which Germany and Poland struggled from 1918 to 1922, first at Paris and later, before and after the plebiscite of 1921, by means of local armed forces. Had it not been for the coal, zinc, and steel of this small area, none of the countries concerned in the conflict would have devoted any great attention to the otherwise unimportant agricultural province—whether it should be left to Germany on the basis of its many centuries of separation from Poland or given to the latter country on the basis of its majority of Polish-speaking population.

As the conflict came to no clear result, either in the plebiscite or in the fighting that followed it, and was particularly confused in the industrial district itself, the final determination made at Geneva in 1922 was a compromise cutting the prize of the conflict in two, giving the greater portion to Poland, the lesser portion to Germany. The district consequently now straddles the international boundary line even more markedly than before the war. The relation of the political boundaries, present and past, to geographic boundaries in this and the neighboring areas was the subject of a previous paper by the author.[1] The aim of the present paper is to present a brief examination of the geography of this bitterly contested district.[2] Political questions will be disregarded except as they have a direct bearing on the matters discussed.

In comparison with its economic importance the industrial district seems extremely small. Only 25 miles in its longer dimension and hardly half that across, it has barely a fourth the area of the Ruhr, perhaps a third that of the Calumet district at Chicago. But, if small,

*The fieldwork on which this study is based was made possible by a fellowship for the year 1931–1932 from the Social Science Research Council. The preparation of maps, etc., was aided with funds granted for that specific purpose by the Rockefeller Foundation through the University of Minnesota.

[1] Geographic and Political Boundaries in Upper Silesia, *Annals Assn. of Amer. Geogrs.*, Vol. 23, 1933, pp. 195–228. See note elsewhere in this number of the *Geographical Review*.

[2] No detailed regional study of the geography of this area has been made since the classic work of Joseph Partsch, "Schlesien: eine Landeskunde für das deutsche Volk" (2 vols., Breslau, 1896 and 1911; reference is to "Oberschlesien," in Part 2, pp. 1–186, also published separately, Breslau, 1903). The events of 1919–1922 brought forth a flood—which still continues—of special studies, written for political purposes, some of which, however, have considerable geographic value, notably those of Volz, Dietrich, and Geisler.

the district is compactly developed (Fig. 3). Its main part consists of a single conurbation made up of six large and many small cities and towns. These, together with the mines and industries, cover

FIG. 1—Location map of Upper Silesia. The industrial district is included approximately between Gleiwitz, Tarnowskie Góry, and Dąbrowa. Symbols: 1, present international boundary; 2, former international boundary; 3, provincial boundary; 4, county boundary; 5 to 8, cities and towns with populations of approximately 100,000; 25,000 to 75,000; 10,000 to 25,000; and less than 10,000, respectively. Scale approximately 1 : 2,000,000.

perhaps one-fourth to one-third of the actual area with "built-up" landscape. Of the intervening rural patches some are in forest, some are waste land, but more characteristic are cultivated fields extending up to the fences surrounding the industrial properties.

RURAL AND URBAN ELEMENTS

The distribution of rural and urban elements shows no clear, readily interpreted pattern, such as is characteristic of districts of greater or more varied relief. A principal feature of the area is the generally level to gently rolling surface, broken only by small streams

flowing in wide, shallow valleys.[3] None of these are navigable, and the small canal connecting with the Oder, at no time important, is now quite without significance.[4] Explanation of the apparently mean-

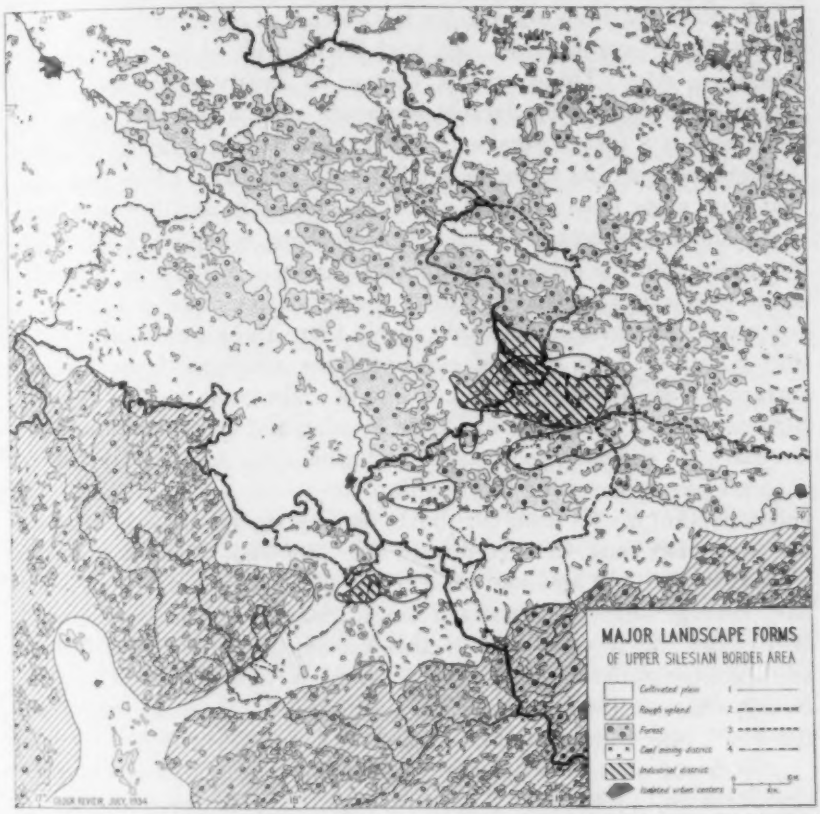


FIG. 2—The Upper Silesian industrial district in relation to the forested plain between the Oder and Vistula valleys. Symbols: 1, watershed between the basins of the Upper Oder, Warta, Vistula, and March (Danube); 2, present international boundary; 3, former international boundary; 4, provincial boundary.

ingless pattern of urban development could probably be found in the routes of the original roads, such as that from the medieval town of Gleiwitz to the old border town of Mysłowice, along which at least

[3] The name "Upper Silesia" (Oberschlesien) is rather misleading. It refers merely to the fact that the area occupies the upstream part of the plain of the Oder, in contrast with Lower Silesia on the northwest around Breslau (not, as frequently supposed, in contrast with the former Austrian Silesia, which is mountainous and considerably higher than Upper Silesia). The regional separation, however, is based on no difference of relief or elevation observable in the landscape but rather on differences originating in the soil and in the population. The suggestion of a plateau or hills as found on many maps and texts is not borne out by observation in the field nor by detailed contour maps. This is shown clearly in "Wirtschafts- und verkehrsgeographischer Atlas von Schlesien," edited by Walter Geisler, Breslau, 1932 (reviewed elsewhere in this number of the *Geographical Review*).

[4] The Klodnitz canal from Gleiwitz to Cosel, on the Oder, is navigable only for small barges, which in 1931 carried less than five thousand tons of coal, which was not one-hundredth of the amount shipped by rail and river via Cosel (Statistik des Oberschlesischen Berg- und Hüttenmännischen Vereins, Gleiwitz, 1932).

four other towns have developed, and also in the routes of railroads, which for the most part antedated the development; but it would be further complicated by many more or less accidental details of mine and factory location.

Similar conditions account for the absence of any dominating center of the district comparable, say, with Pittsburgh or Scranton or Birmingham, Ala. There are six centers of nearly equal size, about 100,000 population, the largest not more than a fourth greater, the smallest not a fourth smaller. There were no preindustrial cities of importance, such as Cologne and Düsseldorf in the Rhineland; only two were more than villages, and these, Gleiwitz and Beuthen, were small and unimportant towns. It is perhaps a general tendency in industrial districts arising in mining areas for a number of centers to develop simultaneously, provided there are no marked factors for concentration. In this case not only is there the absence of any natural points or even lines of concentration resulting from relief or surface waters but there is no crossing of main trade routes. The old highway, now a railroad route, from Breslau and central and northern Germany on the west to Kraków and all Galicia and the Ukraine on the east passes as a wide thoroughfare across the entire district. But the important routes from the south, leaving the Danube countries by the Moravian Gate, diverge toward the Oder and Vistula valleys and so pass to the west and southeast of the district (Fig. 2). Just before they diverge in former Austrian Silesia, however, it might be noted, they cross the western end of the Ostrava-Karvinná coal district, and a concentrated industrial district has developed with only a single center, Ostrava (Mährisch-Ostrau), which is larger than any of the cities of Upper Silesia, though its district is much smaller.

No doubt an additional factor preventing centralization was the absence of any governmental center in the area. The provincial capital for Upper Silesia before the war was 100 miles away in Breslau; for the Russian portion it was still farther distant. Consequently the headquarter offices, main stores, etc. that might have tended to concentrate in a capital city remained scattered among four German cities (Hindenburg not included) and, to the extent that they existed in the Russian portion, in Sosnowiec. On the other hand, the establishment, in 1922, of Katowice as the capital of the province of Polish Silesia has caused that city to develop more rapidly than its neighbor, Królewska Huta (Königshütte).

Boundaries of the District

This uncentralized, amorphous area has, for the most part, rather definite boundaries that separate it sharply from the surrounding farm and forest landscape. It is, in fact, an "island" product of

modern industry, distinctly separated, though by only 70 miles, from the main body of the European manufacturing belt.[5] On several sides the boundary of the area is marked by extensive forests, remnants of those that until a century ago covered the greater part of its sandy plain. Elsewhere the transition is from the open farm landscape with its market towns and farmers' villages of individual houses to the industrial cities and suburbs with their "workers' barracks" and factories. On three sides the boundary is largely determined by the sharp dip of the better "saddle" coal seams. Even where other seams are developed, as on the south, the mines are fewer, and the landscape is predominantly rural. On the east political factors in the pre-war period probably prevented the extension of the industrial development to the limit of the coal area.[6] Only on the north does the industrial district extend beyond the coal-mining area. This, the older area of lead production near Tarnowskie Góry (Tarnowitz), is now the least important part of the district and is much more largely rural.

A Landscape Predominantly Industrial

As in all industrial districts, there is a dense network of transportation features, which, particularly outside the cities, forms one of the dominant features of the landscape and here contrasts most strikingly with the rural systems, especially to the east. Industry here was peculiarly dependent on railroads. In addition to the complex of normal-gauge rail lines, there are the narrow-gauge freight railway connecting mines and industries throughout the entire area, except for the Dąbrowa (Dombrowa) district, and the interurban street-car system that now connects the whole area.

Similarly, the greater part of the region is connected by overhead electric power systems and underground systems of water supply, though these are separated politically into three districts along the present and former boundaries. The water-supply system is of particular concern. Because it lies astride the water divide this densely populated area has no large supplies of surface water, while the larger part of its underground water is spoiled by mining operations. Fortunately the Muschelkalk on the northern margin of the coalfield is rich in water supplies, which are tapped at three or more principal points and pumped throughout the district.

The "island" character of the district is further indicated by the principal forms of landscape development within it. Features of

[5] Valley towns in the Riesengebirge, such as Freiwaldau (Czechoslovakia), have textile and pottery manufactures of early origin, based on water power (H. Aubin, in *Schlesisches Jahrbuch*, 1930–1931, pp. 70–88; Geisler, *op. cit.*, Sheets 10, 12, 13, 35, and 36).

[6] The Galician (Austrian Poland) portion of the coalfield, now called the Kraków basin, had likewise little development in manufacturing, presumably because of the greater advantages in the Ostrava district in Austrian Silesia and Moravia.

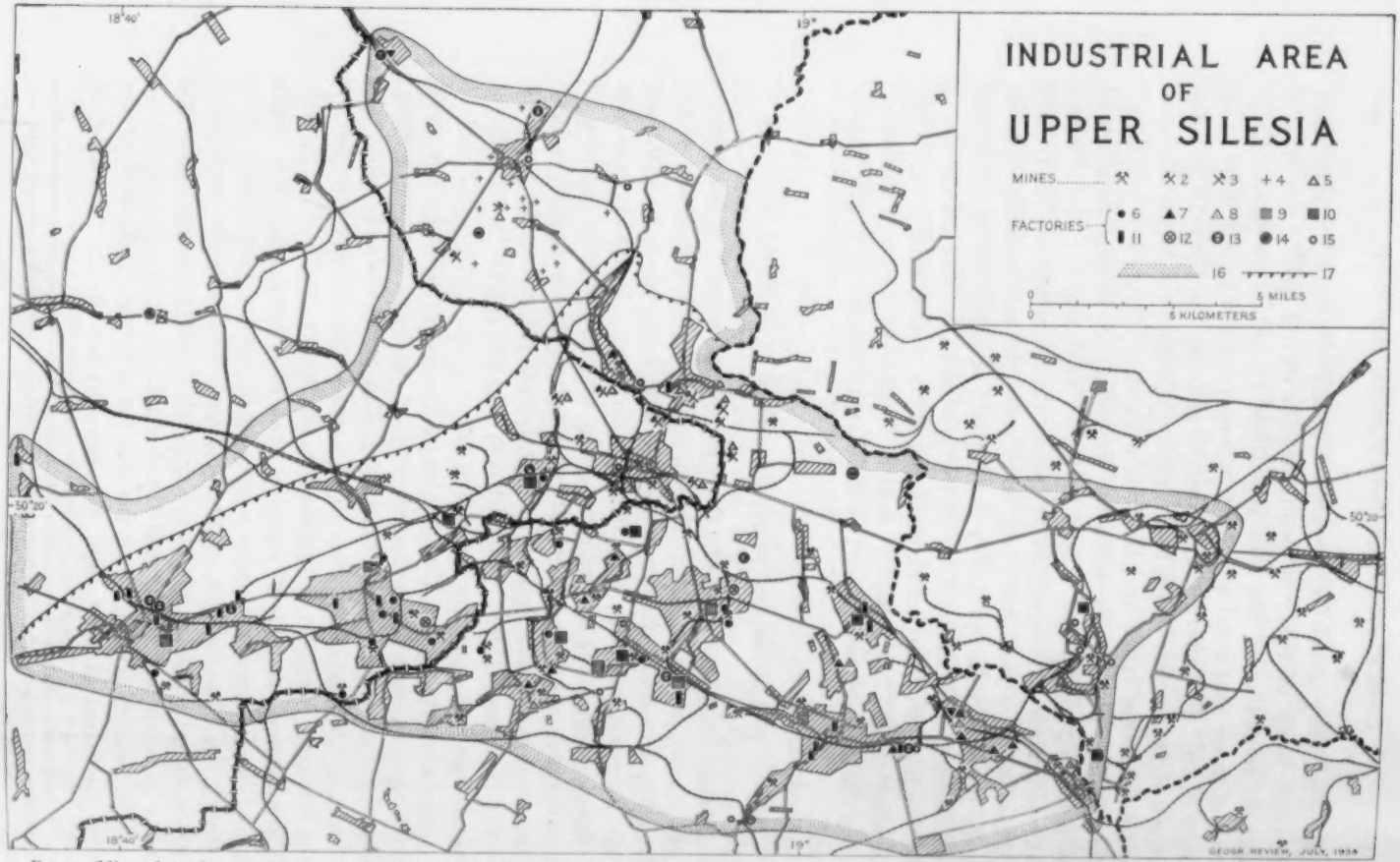


FIG. 3—Mines, factories, and urban areas in the industrial district of Upper Silesia. Symbols: 1, coal mine; 2, zinc mine; 3, lead mine; 4, iron mine (very small); 5, zinc washery; 6, coke ovens; 7, zinc roaster and smelter (reversed is lead furnace); 8, zinc rolling mill; 9, blast furnace; 10, steel mill; 11, iron or steel fabricating plant; 12, electric power plant; 13, chemical industry; 14, main pumping station (wells); 15, other industrial plant; 16, boundary of entire industrial district; 17, boundary of inner industrial district. Shaded areas are "built-up."

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FIG. 4—Detailed map of the cultural landscape near the center of the industrial district. The areas of mine buildings and mills are shown in black; commercial and residence districts, by shading; waste piles and caved-in areas, by hachures; railroads, standard and narrow-gauge, roads, and street-car lines, by the usual symbols. The new international boundary crosses the map from southwest to northeast.

mining and a very few types of heavy manufacturing, together with their characteristic transportation services and urban forms, predominate to the almost complete exclusion of other forms of manufacturing, of commerce, or of other urban elements (Fig. 4). More than in any other manufacturing district of western Europe the landscape here has resulted from the application of modern industrial technique to rich mineral resources in an area of little rural, and even less urban, development.[7]

Before the beginning of the industrial era the sandy plain offered little inducement to agriculture and no water power for manufacturing. Trade on the old continental route, Breslau-Kraków, which in the Middle Ages had made Gleiwitz and Beuthen of some small importance as outfitting points, had later declined both because of the post-Columbian shift to ocean routes and as a result of devastation by wars, especially the Thirty Years' War.[8] The total population of the area now occupied by the industrial district was less than 14,000 in 1756, that of its four towns about 4000.[9] With a present population of over a million, it is clear that the cultural landscape is essentially as young as that, say, of the Pittsburgh district in the United States and even more peculiarly a product of modern industry based on coal and iron.

From the social and political points of view it is important to note that, in contrast with the American district mentioned, the great increase in population in this essentially young district did not come from immigration from foreign lands but chiefly from the local movement of workers from the immediately surrounding agricultural areas, together with an unusually high rate of natural increase within the growing urban district itself, and, to a lesser extent, from the immigration of middle-class groups from other parts of Germany. Most of the population are descendants of Polish-speaking peasants[10] from the surrounding areas, but, as the movement to the cities was largely limited by the international boundary, i.e. the pre-war German-Russian boundary, the main portion of the district received most of its population from the Polish-speaking areas that bordered it on the north, west, and south within what was then Germany.[11]

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[7] An interesting and effective representation of the present landscape of the industrial district on a large-size map is given by Bruno Dietrich: Karte des oberschlesischen Industriedreiecks, Breslau, [1921]. The landscapes of previous periods are described and mapped in "Zwei Jahrtausende Oberschlesien in acht Karten dargestellt," edited by Wilhelm Volz, Breslau, 1920.

[8] Wilhelm Volz: Zum oberschlesischen Problem, Gleiwitz, 1930, pp. 9–13.

[9] F. A. Zimmermann: Beyträge zur Beschreibung von Schlesien, 13 vols., Brieg, 1783–1799; reference in Vol. 2, pp. 200 ff. and 363 ff.

[10] Post-war German literature on Upper Silesia emphasizes the mixed character of the so-called *Wasserpolnisch* dialect in Upper Silesia. The author's reasons for including this dialect with Polish are stated in detail in the article previously cited, pp. 207–208. It must be remembered, however, that the "Polish-speaking" individuals and groups are not necessarily "Polish in national feeling"; compare the German-speaking Alsatians.

[11] According to the study of Maria Vogt, used by Wilhelm Volz in "Die wirtschaftageographischen Grundlagen der oberschlesischen Frage," Berlin, 1921, pp. 47–53.

Mining Features

Features associated with mining remain the dominant elements in the landscape today. They include older open excavations, mostly small, of ore mines and a few coal mines, and a number of quarries and sand and clay pits, but more particularly the surface manifestations of large underground coal and zinc mines. At each coal mine, in addition to the main tipple and often a second shaft, are the sorting plant, power house, repair plant, miners' dressing and shower building, offices, and other buildings including usually a brick works with adjacent clay pit, the coal-storage yards, switch tracks, and, often most impressive of all, the great piles of waste. Farther away two or three scattered shafts rise solitary in the midst of fields or towns. These are used to receive sand to replace coal where cave-ins must be prevented, for air circulation, and similar purposes. At other places sunken fields reveal the presence of underground workings. On the northern edge of the coalfields, near Beuthen, the zinc-lead formations overlie the coal seams, and both coal and ore mines are found on the same field. Associated with the ore mines and, in several cases, connected by overhead cable conveyors are the flotation plants in which the zinc and lead ores are separated. South of this small area, throughout the principal part of the industrial district, coal mines are found nearly everywhere, within the cities as well as outside them.

Although coal is now most important, modern industry started in ore mining in the Triassic dolomite of the Tarnowitz-Beuthen trough.[12] Near Tarnowskie Góry, on the north, ores lying close to the surface first yielded galena, with some silver content, and brown iron ore. But, as most of the lead ore is now exhausted and little of the iron ore is worth working in competition with imported high-grade ores, this area is now the least important part of the district. Important ore mining is restricted to a half-dozen mines immediately north and east of Beuthen, all close to the new international frontier and in several cases overlapping it (Fig. 7). These produce primarily zinc, partly from the overlying smithsonite (zinc carbonate), now more largely from the underlying sulphide ores, separated by flotation into zinc blende, smaller amounts of the more valuable galena, and considerable iron pyrites of low value for sulphuric acid and iron. Most of the production comes from what was originally a single mine, now cut in two by the new frontier. Purely because of this political line a complete new mine and flotation plant have been constructed on the German side.

[12] Partsch, *op. cit.*, pp. 32–83; H. Voltz, edit.: Handbuch des oberschlesischen Industriebezirks, Oberschlesischer Berg- und Hüttenmännischer Verein, Kattowitz, 1913; Paul Deutsch: Die oberschlesische Montanindustrie vor und nach der Teilung des Industriebezirks, *Moderne Wirtschaftsgestaltungen*, No. 9, Bonn, 1926; Paul Zieger: Die Entwicklung der oberschlesischen Kohlenproduktion und des Kohlenabsatzes nach der Teilung Oberschlesiens im Vergleich zur Vorkriegszeit, Greifswald, 1926.

Coal mining had its start, first, to furnish fuel for the water pumps in the lead mines—when, incidentally, the first steam engine was set up on the continent of Europe[13]—later, for smelting the iron and zinc ores. But it grew rapidly beyond that to become by all odds the most important activity of the district, as well as the principal basis for its

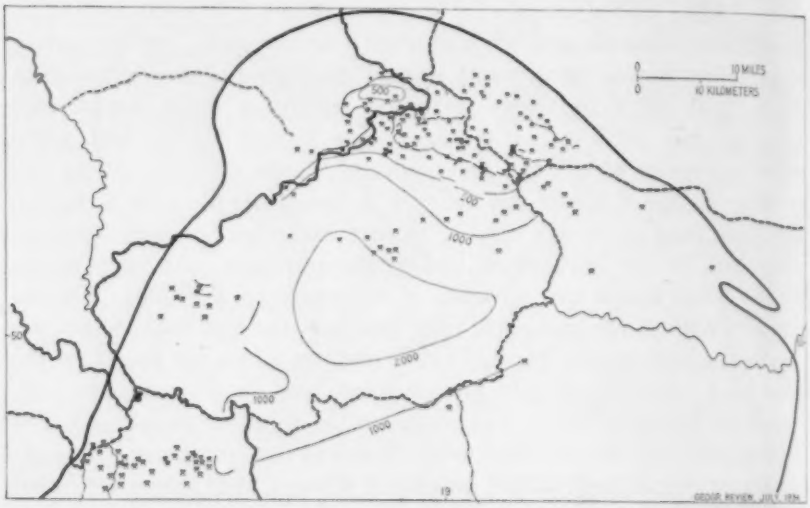

FIG. 5—Coal mines in the Upper Silesian coalfield. The greatest concentration is in the industrial district on the north, extending from German Upper Silesia across Polish Upper Silesia into the Dąbrowa district of (former Russian) Poland; south of that are more scattered mines in the Rybnik-Pszczyna area of Polish Upper Silesia and the Kraków district of (former Austrian) Poland; in the southwest are the concentrated districts of Ostravice and Karvinna, formerly in Austria and now entirely in Czechoslovakia, and a single mine in Polish Teschen (compare Fig. 1). Dotted lines show the depth, in meters, of the more valuable "saddle" seams; the heavy line is the probable limit of the coal area in the northern part of the field.

manufacturing. Geologically the main part of the industrial district is a small portion of the large coalfield that extends south of it at least as far as Ostrava. Mining is particularly concentrated on the northern margin of the basin where an anticlinal fold brings the richest seams close to the surface. Between the 500 and 2000-foot levels underground are some six seams, varying in thickness from 6 to 30 feet or more and totaling about 90 feet of high-grade bituminous coal for steam or household purposes, though, for the most part, poor for metallurgical coke.

That the deeper seams to the south have not been worked more extensively is because of difficulties not so much of production as of marketing. The mines already produce more than three times the amount required for the area itself, and in relation to outside markets the locus of the district is disadvantageous. It lies not merely on the outer margin of the manufacturing belt of western Europe but likewise

[13] In 1788 (Partsch, *op. cit.*, p. 52; Volz, Zum oberschlesischen Problem, pp. 24–25). Goethe was one of the many visitors who traveled from other parts of Germany to Tarnowitz to see this "wonder."

on the border between commercial western and subsistence eastern Europe. Furthermore, it is remote from the sea and has only one very inadequate inland waterway connection.[14]

On the other hand, from the partition up to 1929 special political and economic events encouraged the already excessive extent of mining operations. The great English coal strike of 1926 gave unusual stimulus to coal production throughout western and central Europe. In German Upper Silesia added stimulus came from the occupation of the Ruhr and from the constant desire of the political and industrial leaders to make eastern Germany independent of coal supplies from Poland. In Polish Upper Silesia, on the other hand, the blow of the German embargo against Polish coal since 1925 was mitigated by the opportunity to enter the Scandinavian markets during the English coal strike. The markets obtained then have been retained in considerable part, largely as a result of strong governmental pressure and very low freight rates over the state railroads, which offset in part the long land haul to Danzig and Gdynia.

Manufacturing Features

Manufacturing in the area is practically limited to a few heavy industries, particularly of iron and zinc. Most important are iron and steel mills, including blast furnaces, steel furnaces, rolling mills, foundries, and a number of fabricating plants, particularly for cables and mining machinery. Of secondary importance are the zinc roasting plants and furnaces, with associated sulphuric-acid plants, and a few zinc rolling mills, and the two lead furnaces. There also are coke plants, of relatively small importance (for, as we have said, little of the coal is good for coking), a few large chemical plants, two great power plants, a few cement plants, and a surprisingly small number of miscellaneous factories. The textile industries and other types of "light manufacturing" are conspicuously absent except on a small scale in Sosnowiec, an outgrowth of the former Russian tariffs.[15] The industrial landscape is consequently dominated by factories—high, one-story buildings, with many great chimneys—which require large areas for tracks and storage purposes. With few exceptions, all these plants are situated in the coal-mining area, forming a narrow belt 25 miles long and never over 6 miles wide from Gleiwitz to Dąbrowa.

This limitation of manufacturing to one or two groups of heavy industries distinguishes the district from those of the general manu-

[14] The connection is chiefly by rail to Cosel (about 40 miles), thence down the Oder to Breslau, etc., with canal connection with Berlin. This route handled in the pre-war period less than one-tenth of the total coal shipments from Upper Silesia and now handles about the same proportion of the shipments from German Upper Silesia but none from the Polish portion (Wilhelm Volz: Oberschlesien und die oberschlesische Frage, *Zeitschr. Gesell. für Erdkunde zu Berlin*, 1922, pp. 161–234; Statistik des Oberschlesischen Berg- und Hüttenmännischen Vereins, Gleiwitz, 1932).

[15] E. Wunderlich, edit.: Handbuch von Polen, 2nd edit., Berlin, 1918, p. 442.

facturing belt of western Europe. The absence of other types of manufacturing is the result of a combination of disadvantageous factors that have proved stronger than the advantages of cheap coal and steel and cheap labor: the lack of any preindustrial development of manufacturing, with its resultant resources in skilled labor, experienced management, etc., such as is found in older districts in the highlands farther west; the relative remoteness (for peninsular Europe)

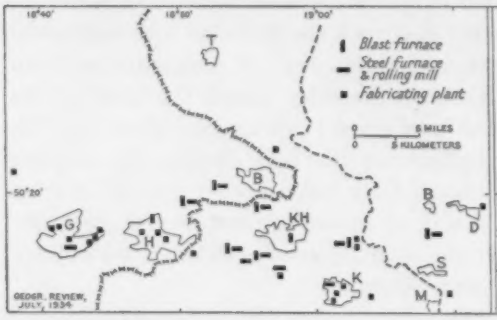

FIG. 6

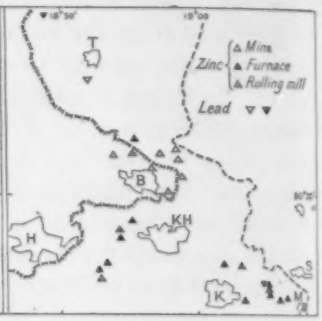

FIG. 7

FIG. 6—The iron and steel industry in the industrial district of Upper Silesia. Compare location map, Figure 1.

FIG. 7—Zinc and lead mining and smelting industry in German and Polish Upper Silesia. Close to each zinc mine is a washery (flotation plant for separating zinc and lead ores); at each zinc furnace is a roasting plant, smelter, and sulphuric-acid plant. The zinc mine immediately east of Beuthen is the new mine built within Germany solely because of the location of the new boundary.

from the sea and hence from oversea materials and markets; the location on the edge of commercial western Europe facing the scanty markets of the subsistence areas of poorer eastern Europe—a contrast emphasized by the lack of road and railroad construction east of the former German frontier; and the political-geographic location of the district in a remote corner of the national-markets area of Germany and Poland and separated from those of the neighboring countries to the south—Austria and Hungary and, since the war, Czechoslovakia.

The zinc and lead smelting industries depend entirely on the local supplies of coal and ores, primarily the former, as the location of nearly all the smelters in the coal area rather than in the ore area indicates—zinc smelting requires 8 to 9 tons of coal per ton of zinc ore (Fig. 7). But since there is more than an abundance of coal available the industry is limited by the amount of ore produced. The rolling mills were always of much less importance because of the remoteness of most of the markets. Since the partition placed most of them in Poland, whereas the greater part of their market was in Germany, their activity has greatly declined, and several have been completely abandoned. All the smelters of both lead and zinc were placed in Poland, so that the entire ore production from mines remaining in Germany crosses the international boundary to be smelted

and then is reshipped back into Germany. This constitutes the principal item of transport as yet undiminished as a result of that line.[16]

Most important of the manufacturing industries is the iron and steel group (Fig. 6). This is scattered throughout the main part of the district, mostly in small units, poorly correlated. Nearly all the plants date from earlier periods, and many units have been or are being abandoned. The local iron ores are now of little importance, and the local coal is surpassed in coking quality by that of other districts. The investment in the plants and the trained labor at hand alone are insufficient to maintain the industry in the face of the permanent handicap of inland peripheral location. The blast furnaces are being rapidly abandoned; the remaining units depend more on scrap iron. In the portion remaining to Germany temporary stimulus was given the steel and fabricating plants by the removal of competition from the plants given to Poland and by the Ruhr occupation, but continued activity has been dependent on financial support, for political and social purposes, from the government in Berlin.[17] In Polish Upper Silesia the change in connections from Germany to Poland meant a great decrease in supplies of scrap iron as well as in markets for products; only the uncertain Russian market has prevented even more rapid decline. The expectation that new steel-consuming industries necessary for the development of Poland, such as locomotive works and munition plants, would be located here has not been realized because of the definite intention of the government, made effective through arbitrary fixing of freight rates, to have no such plants so close to the German frontier.[18]

Because the industries of this region are, many of them, as old as the industrial age itself, they grew gradually, by accretion and by combination. There are none of the carefully planned systems of mills characteristic of our Calumet district, for example. Nor have they shared in the later larger growth that permitted rationalized reconstruction of plants as at Bethlehem, Pa., or in the Ruhr. Furthermore, in such a compact area of crowded mines and towns and unusable mining land, sites for new plants are seldom available beside

[16] Based on figures supplied by individual companies. The *Berliner Börsen-Zeitung* of April 8, 1934, describes the construction of the long-planned new zinc furnace at Magdeburg in central Germany by the chief zinc company of Upper Silesia. When completed this will doubtless handle the ore now being sent from German mines to Polish furnaces and probably much of the production of Polish mines as well, since the final market is chiefly in Germany. This would presumably put out of work some of the furnaces in Polish Upper Silesia.

[17] It is generally admitted by industrialists in the area, including those directly concerned, that the industry would not survive without this support. It is claimed that the social consequences of such decline must be avoided, but the political purpose of maintaining the population of this border district is also very important. A strong case, based on Weber's "Standortstheorie," urging the removal of the industry to Lower Silesia is presented by R. Rassmann: Das Auswanderungsproblem der oberschlesischen Schwerindustrie, *Veröffentl. Schlesischen Gesell. für Erdkunde*, No. 2, Breslau, 1922; and a brief reply, based on a more optimistic view of improvements in coke production, of the development of the Oder waterway, and of specialization in finished products, is given by Deutsch, *op. cit.*, pp. 62–77.

[18] Based on statements of Polish industrial officials.

the old ones. Blast furnaces, steel furnaces, and fabricating plants of the same company are therefore frequently separated; when the flotation process was introduced the "washeries" could not be located, as they should have been, at the mine head. Hence the special importance of the narrow-gauge freight railroad and the numerous overhead cable conveyors. Consequently the political partition of 1922 disrupted industrial interrelationships more than would generally be the case. It led to a reorganization that largely separated the industries along the new boundary and resulted in some cases in increasing the distance between the newly related plants, in more cases in decreasing it.

Urban Development

If the industrial structure of the area is pronouncedly planless, even more so is the urban development. The growth of small towns and villages, at a rate always called "American" by German writers, into large urban agglomerations based on mines and industries alone has produced cities containing within them, often close to their centers, the types of industrial structures that we commonly associate with their peripheries. As we have said, urban foundations on which to build were lacking. The ancient trading settlements, Beuthen and Gleiwitz, with the characteristic Silesian elliptical form about a central *Ring*,[19] were so small that the plants originally located outside them are now nearly surrounded by the modern cities. Hindenburg and Sosnowiec are little more than formless agglomerations of more or less miserable workers' districts around mines and factories. Only since 1914 have they been recognized politically as other than villages and granted city government. Attempts of recent years to plan the reorganization and further growth of these cities are made extremely difficult, not only by the presence of the mining and industrial plants but especially by the inability to build over the mining fields.

Most extraordinary is the case of Beuthen, blocked sharply on the east by the mining of rich ore beds close to the surface and almost equally sharply on the north and south by the new international boundary line. There is an interesting tendency toward the fusion of the three main cities remaining in Germany—Beuthen, Hindenburg, and Gleiwitz—into a single urban area, which, however, would have two commercial and social centers, one at each end, nine miles apart.

Possibly most districts of this industrial type are strikingly ugly and poor throughout the greater part of their residential districts and

[19] A local term in Silesia and Bohemia referring to the market place, which, however, was strictly rectangular, though the outer wall of the town and the streets bordering it were elliptical. Presumably the word is derived from the Polish *rynek*, meaning "market place" (J. and W. Grimm: Deutsches Wörterbuch, Leipzig, 1893).

even commercial centers, but few to such an extent. Certainly in comparison with Westphalia the workers' districts are desperately unattractive.[20] Districts of single houses are even rarer than in most European cities; the better residence areas are composed mostly of apartment buildings. Outside the cities, on the other hand, are found huge, if not handsome, *châteaux* built by the present owners of most of the land—descendants of the feudal nobles who originally possessed it—who own many of the industries also. The common contrast in industrial districts between the large and expensive estates of the few and the small, mean residences of the working masses is found here in its most exaggerated form because of the direct transformation, with no intermediate commercial period, from the feudal agricultural structure of the past into a feudal industrial structure.[21] That such conditions continued, with only moderate change, under the later state socialism of Prussia is an indication of the colonial character of the district. For the economic and political development and control were largely in the hands of outsiders from other parts of Germany, for whom this area was more foreign than German.[22] The vital political consequences of this situation cannot be discussed here, but it should perhaps be stated that this, rather than any originally national interest, was the fundamental factor[23] in the German-Polish conflict that produced what is perhaps the most extraordinary feature of the district—the present international boundary cutting through it (Figs. 3 and 4).

Effects of Boundary Changes

This line, together with the former German-Russian boundary, divides the district into three areas, with significant consequences.[24] The pre-war Russian-Polish portion, i.e. the Dąbrowa district, is strikingly separated from the remainder. Even today only two rail lines, a few roads, and a single street-car line connect this Polish district with Polish Silesia. The mines and factories look much like those in the main district, but the residential sections and street

[20] Ernst Laslowski: Verkanntes Oberschlesien, Beuthen, Upper Silesia, 1933; Rudolph Vogel: Deutsche Presse und Propaganda des Abstimmungskampfes in Oberschlesien, Beuthen, Upper Silesia, 1931. Both of these are German writers who are natives of Upper Silesia, in contrast with most of the German authors who have written about the area from the outside. The latter writer points out that a false impression of the general picture in the industrial district is given in much of the German literature by emphasizing a few exceptional model settlements, notably Gieschewald.

[21] Partsch, *op. cit.*, pp. 7–29; Manfred Laubert [German]: Die preussische Polenpolitik von 1772–1914, Berlin, [1920]; Peter Pampuch [Polish]: 150 Jahre preussische Knechtschaft, Nikolai, 1920.

[22] "Upper Silesia was for a long time considered a kind of colony to which officials might be demoted for punishment (*strafversetzt*) or where one could go to become rich" (Ernst Laslowski [German], from a manuscript).

[23] Vogel, *op. cit.*, pp. 4–27; Ernst Laslowski: Grundlinien der geschichtlichen Entwicklung Oberschlesiens, *Die Provinz Oberschlesien*, July 15, 1931, pp. 281–288; H. Lukaschek [former governor of German Upper Silesia]: Oberschlesische Probleme, *Zeitschr. für Selbstverwaltung*, Nov. 19, 1926.

[24] For a detailed discussion of the effect of these political divisions see the author's article cited in footnote 1 above.

scenes in the commercial cores of the cities are lacking in "German order," to quote a Polish geographer.[25] For the former German area, in spite of what has just been said, does show, in the condition and cleanness of streets, curbs, street cars, and gardens, positive effects in material culture that are lacking in the Dąbrowa district, where economic control from France and political control from St. Petersburg left chiefly negative signs of remote central authorities.

Between the Polish area that was formerly German and the area still remaining in Germany few, if any, differences of this sort are to be found. The landscape on both sides has been relatively little altered in the past ten years, and the two parts are still connected by most of the transportation services and routes. On the other hand, the use of these services, especially by wheeled vehicles, has greatly decreased since the partition. The frontier posts and customhouses at all of the 18 highway crossings and also the permanently closed gates on the less important roads represent barriers to local trade and mark the course of the new international boundary through the heart of the district. On the other hand, as was previously pointed out,[26] this "subsequent or superimposed" boundary remains less effective in the geography of the district than the "antecedent" boundary, now abandoned and unmarked.

[25] Stanislaw Lencewicz: Kurs geografji Polski, Warsaw, 1922, p. 126; likewise noted by Emm. de Martonne: Europe Centrale, Part II (Géographie Universelle, Vol. 4), Paris, 1931, pp. 651–655.

[26] Hartshorne, *op. cit.*

THE MONUMENT OF TIN HINAN IN THE AHAGGAR

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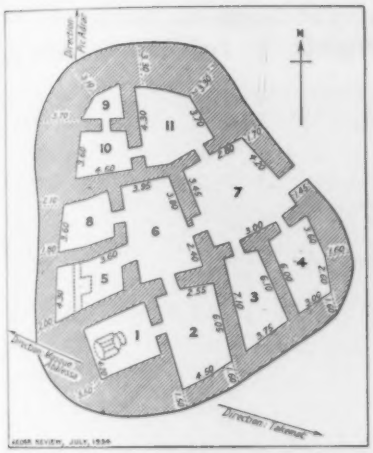

FIG. 1—Plan of the monument of Tin Hinan. Measurements are in meters.

In the winter of 1933 investigation of the monument of Tin Hinan in the Ahaggar was resumed by Maurice Reygasse, of the Ethnographical Museum of Algiers. The importance of the monument, suggested by the finds of the Reygasse-De Prorok expedition,[1] has been confirmed. It throws an interesting light on the past of the Sahara.

PLAN AND DATE

Before excavation the monument presented the appearance of a confused heap of stones, a "redjem," of which there are many in the Sahara. It was exceptional only in its dimensions—26.25 meters on the longer axis, 23.75 meters on the shorter, and with a height of about 4 meters. Excavation revealed the existence of dry-stone walls, rough but regular, the stones carefully placed. The monument as revealed in its entirety is shown in the accompanying plan by M. Reygasse. It contains eleven chambers. The largest, No. 7, is an irregular quadrilateral, with sides 6 or 7 meters long; the smallest, No. 9, still more irregular, has sides of from 2 to 3.5 meters in length. The whole is enclosed by a wall 3.7 meters thick in one part, even 4 meters in another, and never less than 1.5 meters. As far as one can judge, there were no windows; certainly there was only one door, of a fair width (1.8 meters), communicating with the exterior by room No. 7, which apparently functioned as a general antechamber, for from it all the other rooms are accessible by doorways, all but one (1.4 meters) a little less than 1 meter in width.

The chief interest of this curious edifice is its date. Among the furnishings found by M. de Prorok in the funerary chamber that he excavated was a wooden bowl of a kind still used in the Ahaggar as a container and drinking vessel for camel's milk. On the bottom of the

[1] See E. F. Gautier: The Ahaggar: Heart of the Sahara, *Geogr. Rev.*, Vol. 16, 1926, pp. 378–394, reference on pp. 383–384; M. Reygasse: Ethnographie, *in* Les territoires du sud de l'Algérie, Part 5, Programme d'action économique, Commissariat Général du Centenaire, Algiers, 1930, pp. 81–111, reference on pp. 99–100.

bowl was the impression of a coin, described by the late Stéphane Gsell and M. Adrien Blanchet as that of a gold piece of Constantine. The skeleton of Tin Hinan lay in a bent posture on the decayed fragments of a bier of wood and leather. This circumstance together with the general aspect of the tomb and its furnishings is incompatible with Moslem burial. Thus the earlier findings gave us outside dates—after Constantine and before the introduction of Islamism. This, however, leaves a fairly wide range of possibilities: the coin may have been

FIG. 2—The upper part of the monument of Tin Hinan before excavation. The ribbon of verdure in the background is Wadi Abalessa.

deposited long after it was struck; the date of the introduction of Islamism is not known precisely.

An object brought to light by M. Reygasse in the recent excavations does much to trim the edges of uncertainty. This is a Roman lamp—two lamps, indeed, were found, but one is fragmentary—in a perfect state of preservation. Black smoke stains that have penetrated the clay indicate long use. The base bears no potter's mark. On the anterior face can be distinguished a winged victory and what appears to be a trophy. Our museums contain innumerable examples of Roman lamps, and the development of technique and style can be traced as one can trace the evolution of any other piece of furniture. It has been studied as minutely by the archeologists as, for example, the evolution of the ammonites has been studied by the geologists. The archeologists report that the lamp of Tin Hinan dates from the third century of our era—one may even go so far as to say the middle of the third century. Here then we have the impression of a coin of Constantine (337–340 A. D.) and with it a Roman lamp of the third century showing signs of long use, with the débris of another lamp

attesting, if this is necessary, the natural fragility of a clay lamp in use. It is likely enough, then, that the tomb is of the fourth century; in any case it is contemporary with the later Roman Empire.

Significance of the Monument

The Sahara is covered with stone mounds that have been excavated by the hundred; but all others have contained only skeletal remains:

Fig. 3—Room 7 in the monument of Tin Hinan after excavation. Note the regularity and massiveness of the dry-stone walls.

they are simple sepulchers in the Libyan fashion. The excavations of 1933 at the tomb of Tin Hinan brought to light débris of wood and ironwork belonging to doors and roofing. In chamber No. 5 a rectangular heap (see Fig. 1) represents perhaps a funerary altar. Only No. 7, the general antechamber, seems to have been open to the sky. Here then is a real monument, 1500 years old. It is situated at Abalessa in the Ahaggar massif, almost in the heart of the great desert.

What was its purpose? Assuredly it was a sepulcher. In the single room that the De Prorok expedition excavated in 1925 (No. 1 on the plan) the skeleton of Tin Hinan was found. But the excavations of 1933 have brought to light other rooms none of which show use for inhumation. Their floors were roughly paved, and they may have been used for living purposes or, perhaps, as storehouses. The architecture of the monument suggests a fortification—the way in which the rooms are blocked up; the strong encircling wall with no other entrance than a single door; and, above all, the fact that traces of a moat surround the wall. In the general antechamber, on the threshold

of the single door—the place where a sentinel would naturally be stationed—iron arrowheads were found.

The monument of Tin Hinan was then a fortified tomb doubly protected—by the moral protection of a venerated body and the material protection of a garrison of archers.

Who built the monument and who were its guardians? Part of the furnishings are certainly Mediterranean, i.e. Greco-Roman. In addition to the coin of Constantine and the lamp there were fragments of a large vase and an engraved glass that unquestionably were Mediterranean. Fragments of pottery made on the wheel are presumably of the same origin. Can one then conclude that here was a Roman post? Scarcely. The farthest Roman posts in the Sahara of which we know are Ghadames (Cydamus) and Garama in Fezzan (the country of the Garamantes; Phazania): literature and inscriptions attest their character. But Abalessa is a thousand kilometers south of Ghadames, 1200 kilometers to the southwest of Garama. Literature is silent on Abalessa and the Ahaggar, and so far no Latin inscription has been brought to light. The architecture of the monument is not that of a Roman post. The irregularity of plan, the roughness, and the masonry remind one rather of a Berber ruin.

The remainder of the abundant furnishings are in some cases of doubtful Mediterranean origin, in other cases clearly of African origin. A copper tube enlarged at one end has not been identified by the archeologists. Massive gold bracelets of rather coarse workmanship are not specifically Mediterranean: the gold of the Sudan was well known in ancient times. Two iron bracelets, one of twisted, and the other of plaited, design, suggest negro craftsmanship: the Sudan, a country of lateritic iron ore, is perhaps the corner of the world where ironworking was born. Beads and pendants of a gold necklace are of curious workmanship, in part of fine filigree but on the whole of rather barbaric appearance. The beads of a silver necklace made from a folded sheet of metal have not yet been recognized.

There are many beads of nonprecious material. Here we might expect glass beads of Mediterranean provenance: there are only three, however. The others, some forty, are of natural stone polished and pierced—amazonite, agate, cornelian, chalcedony. Chalcedony, we know, gave its name to Carthage (Karchēdōn), which exported the Sudanese product to the Mediterranean world. We know also that in antiquity the Sahara passed as the country of the Garamantian emeralds. In our time beads supposed to have come from sepulchers and called "pierres d'Eygriss" by the French traders on the Guinea coast[2] are greatly prized. Frobenius describes negro workmen at

[2] See Maurice Delafosse: Haut-Sénégal-Niger (Soudan Français), Ser. 1, Vol. 2, Paris, 1912, p. 69, footnote 3 (continued on p. 70). These would seem to be the aggrey beads of the British West African colonies: their origin is disputed. See A. W. Cardinall: The Gold Coast, 1931, Accra, n. d., p. 12.

Ilorin, Nigeria, who knew perfectly how to work in agate and jasper.

In the funerary chamber De Prorok found a curious amulet, fashioned of the natural plaster very common in the Sahara and representing a steatopygous goddess, the Hottentot Venus, which assuredly is African. The presence of the amulet emphasizes positively the negative fact that no trace of the Christian cult of the fourth century of our era—a time when the Roman Empire officially was Christian—has been found.

Conclusions

In sum, then, we have an edifice at once sacred and fortified, whose furnishings attest or suggest two diverse influences—Roman and negro. It may have served as a way station—a stage between the Roman Mediterranean and black Africa. Mediterranean influences in western Africa are very ancient, going back to Carthage and the periplus of Hanno. They inevitably underwent a remarkable development with the introduction of the camel. About the fourth century of our era camel raising was carried on around Leptis Magna (Tripoli), and it was conducted there on a large scale for perhaps a century. Leptis Magna has probably always lived on trans-Saharan commerce, especially after this incomparable medium of transportation was at its disposal. If Amsterdam is built on herrings, Leptis Magna, said Gsell, was built on camel carcasses. Gsell also advanced an interesting hypothesis regarding the conquest of the Sahara by the Berbers.

Roman Africa continually advanced the reclamation for agricultural purposes of the wide empty spaces used as pasturage by the wretched shepherds and their miserable flocks. This steady push of the nomad Berbers beyond the frontiers, to the Sahara, was coincident with their acquisition of the new and precious camel. The Ahaggar was well placed to take part in the great transformation that ensued: its prolongation to the south of Aïr is the mountainous border of the Fezzan basin. Caravans have always preferred this highland route. Barth, the first European traveler to reach the Sudan from Tripoli, went by Ghat to Aïr.

It is then readily conceivable that in the fourth century of our era some Ahaggar kinglet, a descendant of Tin Hinan, if you like, atavistically came under the influence of Rome, maintaining relations with the Roman-Punic traders of Leptis Magna, Cydamus, and Carthage. These traders engaged in trans-Saharan traffic had need of him and he of them. He sold them his protection and established on his territory a way station. Thus one might interpret the monument of Tin Hinan—a stage on the road to the country of the blacks. If so, there should be others, and it is possible that they may be found.

THE INTERVAL BETWEEN TREE AND PASTURE LINES AND THE POSITION OF THEIR EXTREMES

Werner Heybrock

IN his paper "Height Limits of Mountain Economies" in the *Geographical Review* Peattie[1] has made some interesting remarks about the difficulty of determining definite altitudinal zones in mountain regions. He has also pointed out, and with truth, that the analysis can be improved only at the cost of the uniformity of the picture of the zones: and he repeats the remark of Krebs, who finds it necessary to abandon the use of zones. However, in individual cases zones remain comparable with one another, and the zonal conception is indispensable for the investigation of the conditions of climate and vegetation.

Attention has generally been concentrated on the vegetation lines alone, without regard to the intervals between them and the position of their extremes. It is this phase, as regards the tree and pasture lines, with which I am concerned in the present paper. The inspiration for the investigation came from an observation in the upper Esera Valley (Plan des Étangs), in the Spanish Central Pyrenees, where, contrary to expectation, the upper limit of the tree line was found to be higher on the northern than on the southern exposure, while the upper limit of the pasture line showed an entirely opposite tendency. This smaller interval between tree and pasture lines on the northern than on the southern exposure does not turn out to be an exceptional case, as my investigations show. I have collected a number of instances, mostly from the Alps (Table I). They were taken partly from maps of the Eidgenössische Landestopographie (Service Topographique Fédéral) and of the Deutscher und Österreichischer Alpenverein, Vienna, and partly from observations of my own. They refer to northern and southern exposures and are based upon the extreme upper limits of trees and of pasture without regard to the local conditions of soil, steepness of terrain, or climate. However, on principle, only such values have been taken as, by their position, are based upon undisturbed, natural growth of the vegetation, with its upper limits well exceeded by the mountain summits. The selection of cases was made quite arbitrarily as data were available; no region was preferred or neglected purposely. There is, of course, no completeness to the table, and the results cannot claim a final value, but the figures do suffice to show the character of the phenomenon and the possibility of deriving some rules in regard to it.

[1] Roderick Peattie: Height Limits of Mountain Economies, *Geogr. Rev.*, Vol. 21, 1931, pp. 415–428.

The Difference between Northern and Southern Exposures

The large difference between the vegetational intervals on the northern and southern exposures is most striking. The average of 25 observations gives an interval of 397 meters between tree and pasture lines on the northern exposure; the average of 26 observations, on the other hand, one of 666 meters for the southern exposure. One might expect a somewhat higher limit of the pasture line on the southern exposure on account of the increased insolation; but the total discrepancy is surprising. Examination shows that the difference is mainly to be attributed to the fact that the tree line on the southern exposure descends below that on the northern exposure, instead of ascending, as the pasture line does, though perhaps in a smaller degree. The phenomenon appears most clearly when the observations from the northern and southern slopes of the same valley are grouped by pairs. Eleven observations give a 158 meters lower average height for the tree line on the southern exposure. Since the difference between tree and pasture lines on northern and southern exposures is 348 meters for the same 11 observation points, this would mean that the tree line contributes some 45 per cent to the large interval between the tree line and the grass line on southern exposures.[2]

Causes and Possible Influence of Foehn

The greater height of the pasture line on the southern exposures can, as we have said, be explained by increased insolation, but the opposite behavior of the tree vegetation is not so easily accounted for. The general climatic conditions are the same for the slopes of the same valley. Local causes are likewise negligible, since, as the tables show, the various intervals are everywhere comparable and are not connected with the geographical latitude but only with the direction of exposure. One may think of the foehn as a cause; but the slopes not affected by foehn do not show any distinguishing features when compared with those frequented by foehn. If the greater number of the effects of this kind of wind attain their real influence and importance far below the pasture line, some influence due to increased insolation should be noticeable there, even on the northern exposure, on account of less cloudiness during the foehn.

We may elaborate this a little. The Norwegian highlands, for example, from which observation 39 was taken, may have snow squalls, cold weather, and much cloudiness as early as September because of a cyclone over Finland or the White Sea, which at the same

[2] The only exception is observation 8 (Grindelwald), where the interval for the southern exposure is only 150 meters larger. However, it must be considered that the morphological resemblance of both valley slopes to which there was a tendency in the other observations is extremely small here. The slope of the southern exposure culminates at 2684 meters, the opposite one at 3975 meters (Eiger). Furthermore, the angles of inclination of both slopes are different, and the one has a glacier.

TABLE I—EXTREME HEIGHTS OF TREE AND PASTURE LINES ON NORTHERN AND SOUTHERN EXPOSURES AND THEIR INTERVALS

(*Heights in meters*)

No.	DISTRICT AND (AUTHORITY)*	ALTITUDE OF VALLEY	EXPOSURE AND EXTREME ALTITUDE TREES		PASTURE	INTERVAL AND EXPOSURE NORTH	SOUTH	EXTREME HEIGHT CHALETS
	Western Alps							
1	Bourg-St. Pierre (a)	1837	N	2190	2610	420	760	2060
			S	2000	2760	...	....	2114
2	Champsec (a)	910	N	2020	2490	470	890	2080
			S	1920	2810	...	....	2180
3	Ru Vessona (a)	1920	N	2265	2690	425	....	2380
4	Vaud (a)	1476	S	1890	3000	...	1110	2291
5	Zermatt (b)	1940	N	2340	2735	395	868	2208
			S	2010	2878	...	....	2310
6	Macugnaga (b)	1202	N	2220	2580	360	600	2015
			S	2100	2700	...	....	2180
7	Arolla (z)	2000	S	2310	2900	...	590	2407
8	Grindelwald (z)	946	N	1860	2340	480	540	1905
			S	2010	2550	...	....	2132
9	Maloggia (c)	1817	N	2110	2520	410	880	....
			S	1880	2760	...	....	2046
10	Berninahäuser (c)	2049	N	2175	2640	465	630	2113
	(z)	....	S	2070	2700	...	....	....
11	St. Moritz (c)	1771	N	2220	2640	420	810	....
			S	2130	2940	...	....	2185
12	Sils (c)	1800	S	1920	2550	...	630	1950
13	Silvaplana (c)	1795	N	2220	2700	480	....	2260
14	Pontresina (c)	1803	N	2150	2550	400	....	2243
15	Morteratsch (z)	1899	N	2130	2580	450	....	2395
16	Alp Grüm (c)	1781	S	2130	2820	...	690	2142
17	Val Malenco (c)	1430	S	2260	2870	...	610	2326
					Average	431	739	....
	Eastern Alps							
18	Oberstdorf (z)	815	N	1787	2270	483	....	1845
19	Parseier-Spitze (d)	1815	N	2070	2400	330	....	....
20	Parseier-Spitze (d)	860	S	2045	2565	...	520	1828
21	St. Anton (d)	1287	S	2019	2534	...	515	....
22	Dürreggertobel (e)	1600	S	1980	2425	...	445	1861
23	Johanneswanne (e)	1800	S	1960	2405	...	445	....
24	Otterbach (d)	1450	N	1975	2318	343	....	....
25	Alperschon-Tal (d)	1900	N	2070	2375	305	....	....
26	Kaiser-Tal (d)	1875	S	1980	2550	...	570	....
27	Imst (d)	740	S	1930	2612	...	682	....
28	Angerle-Tal (f)	1871	N	2050	2375	325	....	2041
29	Almajur-Tal (g)	1600	N	2120	2456	336	520	....
			S	2080	2600	...	....	....
30	Contrinhaus (h)	2007	N	2200	2675	475	....	2272
31	Pellegrino (h)	1910	S	2065	2725	...	660	2149
32	Innerstein (i)	1398	N	1964	2200	236	595	....
			S	1880	2475	...	....	....
33	Campitello (k)	1421	S	2280	2830	...	550	2200
34	Teischnitztal (l)	1800	N	2200	2600	400	800	....
			S	2020	2820	...	....	2050
35	Mooserboden (z)	1962	N	2020	2280	260	....	....
36	Leitertal (z)	2000	S	2185	2860	...	675	....
					Average	349	581	....
	Central Pyrenees							
37	Bagnères-de-Luchon (z)	1300	N	1880	2350	470	....	....
38	Esera Valley (z)	1800	N	2220	2560	340	730	....
			S	1950	2680	...	....	....
					Average	405	730	....
	Central Norway							
39	Böverdalen (z)	542	N	1075	1530	455	....	1110
				Total	average	397	666	....

* Explanation of Authority, see opposite page.

time causes warm, clear foehn weather over Sweden. On the other hand, the northern Alps around Oberstdorf (Germany) may be favored by extremely warm and dry foehn weather as early as February, while over the Alps proper a dense cloud bank (foehn wall) stagnates and the mountains beyond it have overcast, moist weather. Both cases represent typical meteorological conditions and are not at all rare, but no essential difference is to be distinguished in the intervals between tree and pasture lines.

Also, the Grindelwald area, which is not much affected either by the foehn, as Oberstdorf is, or by severe Atlantic cyclones, as the Norwegian mountains are, does not show any essential differences in the relation between tree and pasture lines from that found on other mountains so characterized. The enormous north flank of the Eiger, higher than 3000 meters (top 3975 meters, valley bottom 946 meters), accommodates itself throughout to the line intervals found before. The southern exposure of Grindelwald has indeed a higher tree line but is without foehn, which is the more remarkable. The southern exposure of Arolla (southern Switzerland), in the valley basin of which the air has a strong tendency to stagnation, as in Grindelwald, is also without foehn. The vegetation in both places is little disturbed and, favored also by intense insolation, thrives. The upper limit of the tree line of 2310 meters elevation without doubt approaches closely the absolute maximal tree line of the Alps and is surpassed in the table only by the northern-exposure value of Zermatt (Table I, No. 5). One of its causes is certainly the lack of ventilation of the valley so that "weather trees" are quite sporadic and extremely rare.

The interval in the French Central Pyrenees at the same point on the northern side of the Porte de Vennasque (2417 meters), which has been considered by Peattie in the *Review*,[3] shows again a normal value for the northern exposure, although the region is presumably not without foehn frequency. On the southern (Spanish) side of this border wall, however, where the foehn is lacking, the interval is about 100 meters larger than on the northern side. But on the opposite side of the same valley (upper Esera), on a northern exposure, the

[3] As regards Dr. Peattie's measurements at the Porte de Vennasque, I doubt the value of the temperature reading in the sun with an ordinary thermometer (*op. cit.*, p. 422). Values thus determined vary according to the size and contents of the bulb (mercury or alcohol, light or dark in color), according to the distance and the reflective qualities of the ground (inclination, color, and density), and, not least, according to the wind velocity.

It may also be noted that the height of the Carpathians given in the table (*ibid.*, p. 426) is obviously in error: even including the High Tatra, the culminating peak, the Gerlsdorfer Spitze, is only 2663 meters.

[4] Explanation for Table I. Maps of the Service Topographique Fédéral: (a) Col du Grand St. Bernhard, 1 : 50,000; (b) Theodulpass, 1 : 50,000; (c) Berninapass, 1 : 50,000. Maps of the Deutscher und Oesterreichischer Alpenverein, Vienna: (d) Lechtaler Alpen, 1 : 25,000; (e) Lechtaler Alpen, Klostertaler Gruppe, 1 : 25,000; (f) Lechtaler Alpen, Heiterwand- und Muttekopf Gebiet, 1 : 25,000; (g) Lechtaler Alpen, Arlberg Gebiet, 1 : 25,000; (h) Marmolatagruppe, 1 : 25,000; (i) Brennergebiet, 1 : 50,000; (k) Langkofel- und Sellagruppe 1 : 25,000; (l) Glocknergruppe, 1 : 25,000. (z) Observations of the author.

normal interval exists again, while the foehn is presumably lacking. This is the more surprising since the tree line in this case, as mentioned before, is considerably higher on the northern than on the southern exposure. The causes may be partially explained, but only partially, by more favorable wind and soil conditions. The latter are, as is well known, not at all uniform in the upper Esera Valley.[4]

All this makes it clear that the foehn cannot be the cause of the difference of interval of the maximal tree and pasture lines on the northern and southern exposures.

Investigation of the East-West Exposures

Approaching the solution of the problem in another way, I collected a series of observations of the east-west exposures (Table II). The figures were taken under the same conditions and assumptions as those for the north-south exposures. They are limited to the Alps, since observations from other mountains are lacking.

The mean values of this table show that the interval between the tree and pasture lines is almost the same for eastern as for western exposures. But in details the distribution of the intervals is not uniform. The amplitudes are large on both sides, but they shrink occasionally to almost complete equality of interval (the insignificant difference of observation No. 14 is within the limit of error).

The interval on the eastern exposure appears to be somewhat larger in the Swiss and also in the Austrian Alps. This conclusion is confirmed by comparing the observations by pairs of east-west exposures close together, as on opposite sides of a valley. Out of 18 observations an average interval of 555 meters is obtained for the eastern exposure, an interval of 520 meters for the western exposure. The difference of 35 meters is not very large, but it exists, and it would be even larger if one gave full weight to the observation from Valle Fontana (Table II, No. 15). Here the upper tree line reaches, according to the map, the abnormal height of 2625 meters, making an interval of only 122 meters with the pasture line—apparently a mistake on the map, which otherwise is very good. At least the value of 2625 meters should be accepted with reservation, and it was not used for calculation of the average.

Further investigation of the behavior of both vegetation lines shows that the tree line ascends with the pasture line on the western exposure, thus taking quite a different attitude from that of the north-south group. At the same time the difference between the interval here is

[4] See, for instance, the report in "Campagne spéléologique de 1928 dans le massif des Monts Maudits," *Bull. Pyrénéen*, Vol. 34, 1929, pp. 136–144. The report is unsigned, but it was presumably written by Mr. Norbert Casteret, who in July, 1931, discovered the phenomenon of the Trou du Toro in the upper Esera Valley (Norbert Casteret: Le problème du Trou du Toro, détermination des sources du Rio Esera et de la Garonne Occidentale, *Bull. Soc. d'Hist. Nat. de Toulouse*, Vol. 61, 1931, pp. 89–132).

TABLE II—EXTREME ALTITUDES OF TREE AND PASTURE LINES ON EASTERN AND WESTERN EXPOSURES AND THEIR INTERVALS

(Height in meters)

No.	DISTRICT AND (AUTHORITY)*	ALTITUDE OF VALLEY	EXPOSURE AND EXTREME ALTITUDE TREES		PASTURE	INTERVAL AND EXPOSURE EAST	WEST	EXTREME HEIGHT CHALETS
	Western Alps							
1	Ollomont (a)	1337	E	2275	2975	700	....	2425
2	Vaud (a)	1500	E	2100	2725	625	600	2350
			W	2050	2650	...	....	2141
3	Praz de Fort (a) . . .	1153	E	2020	2610	590	....	....
4	Bourg-St. Pierre (a) .	1604	W	2010	2820	...	810	2221
5	Ferret (a)	1707	W	1980	2760	...	780	1961
6	Haudères (b)	1433	E	2070	2850	780	725	2404
			W	2175	2900	...	....	2484
7	Val de Nendaz (b) .	2040	E	2250	2610	360	330	2046
			W	2310	2640	...	....	2200
8	Val d'Hérémence (b) .	1608	E	2290	2640	350	330	2310
			W	2280	2610	...	....	2411
9	Saas-Grund (c) . . .	1562	E	2220	2760	540	510	....
			W	2310	2820	...	....	....
10	Breuil (c)	2004	E	2310	2850	540	560	....
			W	2260	2820	...	....	....
11	Randa (c)	1445	E	2130	2970	840	620	....
			W	2280	2900	...	....	....
12	Val Roseg (d)	2000	E	2135	2665	530	450	2263
			W	2280	2730	...	....	....
13	Valle di Sacco (d) . .	2000	E	2390	2820	430	330	....
			W	2370	2700	...	....	....
14	Samaden (d)	1709	E	2200	2700	500	510	2233
			W	2190	2700	...	....	2436
15	Valle Fontana (d) . .	1553	E	2290	2760	470	(122)	2213
			W	(2625)	2747	...	....	2281
								....
					Average	558	546	....
	Eastern Alps							
16	Parseier Tal (e) . . .	1450	E	1935	2653	718	626	....
			W	1974	2600	...	....	....
17	Ssachtal (f)	1388	E	2075	2538	473	400	1917
			W	2150	2550	...	....	1910
18	Val di Contrin (g) . .	1782	E	2220	2600	380	320	2224
			W	2200	2520	...	....	2022
19	Kalkkögelgruppe (h) .	1650	E	2100	2500	400	....	....
20	Gossensass (i)	1098	E	1950	2450	500	700	....
			W	1975	2675	...	....	1830
21	Volderertal (i)	1466	E	1950	2650	700	390	2080
			W	2250	2640	...	....	1934
22	Matrei (i)	992	E	2000	2505	505	570	1825
			W	2080	2650	...	....	....
23	Zamser Grund (k) . .	1671	E	2230	2640	410	700	....
			W	2220	2920	...	....	....
24	Schrahnbachkar (k) .	1635	E	1960	2788	828	....	2085
25	Hintertux (k)	1488	W	2100	2683	...	583	....
26	Wildlahnerbach (k) .	1800	W	2110	2800	...	690	2290
27	Kapruner Tal (z) . . .	1580	E	1980	2800	820	680	....
	(l) . . .	....	W	1970	2640	...	....	....
28	Fuscher Tal (l) . . .	1149	E	1925	2620	695	....	1853
29	Tauernmoosboden (l) .	1981	W	2085	2620	...	535	1882
								....
					Average	584	563	....
								....
				Total	Average	570	554	....

*Explanation of Authority. Maps of the Service Topographique Fédéral: (a) Col du Grand S.; Bernhard, 1 : 50,000; (b) Matterhorn-Arolla-Gd. Combin, 1 : 50,000; (c) Theodulpass, 1 : 50,000t (d) Berninapass, 1 : 50,000. Maps of the Deutscher und Oesterreichischer Alpenverein, Vienna: (e) Lechtaler Alpen, 1 : 25,000; (f) Schladminger Tauern, 1 : 50,000; (g) Marmolatagruppe, 1 : 25,000; (h) Brennergebiet, Nebenkarte, 1 : 25,000; (i) Brennergebiet, 1 : 50,000; (k) Zillertaler Alpen, Westliches Blatt, 1 : 25,000: (l) Glocknergruppe, 1 : 25,000. (z) Observations of the author.

78 per cent due to the tree line. This leads to the assumption that the cause of the interval difference of the east-west exposure is somewhat different from that of the north-south exposure—a cause that cannot be explained directly and perhaps not entirely by the different aspects relative to the sun.

Since in the daily march of temperature the maximum normally occurs in the early hours of the afternoon, the western slopes should normally receive more heat than the eastern slopes. However, the usual afternoon time of maximum temperature frequently becomes one of maximum cloudiness, so that on many days the slopes exposed to the east will get normal insolation, while the slopes exposed to the west get little insolation. But, on the whole, the advantage lies with the western exposure.

Position of the Mean Maxima

The following table (III) gives data on the position of the average maximum height of the tree and pasture lines in the Alps.[5] According to this table the pasture line has a minimum on the northern exposure with a small component to the east, thus approximately on the north-northeast exposure, corresponding, beyond doubt, to climatic conditions, since the minimum of insolation and maximal duration of snow cover also coincide here. The mean maximum elevation of the pasture line, on the other hand, comparing north-south with east-west, is on the western exposure. But owing to a southeasterly component the *true* orientation of maximum is approximately the southwestern. That corresponds somewhat to the insolation maximum, but, regardless of the phenomenon of cloudiness mentioned above, the effect of another, yet unknown, factor would have to be added—the maximum of precipitation and humidity, which in the Alps, apart from the snow-drifts during the winter, lies approximately on the northwestern exposure, according to estimates. The result of all components would then be nearly on the west-southwestern exposure, quite close to the value for the pasture-line maximum. The remaining difference is within the limit of error. This is in harmony with the requirements of the grass vegetation, dependent mainly on the warmth of the sun and satisfied by a minimum of moisture, and with the fact that the summer snows of the northern component of the western exposure are unfavorable for grass.

With respect to the tree vegetation, it is striking that there are two maxima and two minima, the first in a meridional, the second in a

[5] The absolute maximum of the vegetation line, if existing, seems still to be unknown. On the summit of the Piz Palü (3912 meters), Bernina region, I found at about 3900 meters lichens still clinging to the rough surface or in the crevices of the bare rock. It is doubtful whether that represents the absolute upper limit. Owing to the lack of rain at this altitude, the plants are dependent on the small amount of melted snow—little enough on this steep side throughout the year and almost completely missing during the summer months.

latitudinal, direction. This result is somewhat unexpected after the experience with the north-south exposures. But a closer consideration shows the following: the main maximum is approximately on the west-northwestern exposure, near the maximum of moisture; the secondary maximum is approximately on the northeastern exposure, near the minimum of insolation. Furthermore, the main minimum

TABLE III—MEAN VALUES OF THE MAXIMUM HEIGHTS OF TREE AND PASTURE LINES IN THE ALPS

(*Heights in meters*)

EXPOSURE	TREE	PASTURE
North	2107	2501
East	2125	2695
South	2042	2706
West	2157	2841
Average	2108	2686

TABLE IV—MEAN VALUES OF THE MAXIMUM HEIGHTS OF THE DAIRIES IN THE ALPS

(*Heights in meters*)

EXPOSURE	ALTITUDES
North	2140
East	2159
South	2139
West	2143
Average	2145

on the south-southwestern exposure almost coincides with the maximum of insolation; and the secondary minimum on the north-northwestern exposure, with the temperature minimum. That leads to the conclusion that the tree vegetation in the high regions prefers moist and shady slopes[6] to dry and sunny ones. Thus the low position of the tree line on the southern exposure would not be attributed so much directly to the intense insolation as to the rapid drying up that this causes and also to the physiological effect of the wind, which occasionally is even greater than the evaporation effect. Less influential is the position of the minimum of precipitation, which is not identical with the position of the maximum of insolation but oriented approximately on the eastern exposure and thus comparatively near to the shadow sector preferred by the tree vegetation.

CONCLUSIONS

The deviation of the limits of the tree and grass vegetation may be illustrated by Figure 1. Both ellipses are oriented eccentrically to the points of intersection of meridional and latitudinal axes. But the centers of gravity have different positions: the center of the pasture curve is situated in the northeast, that of the tree curve in

[6] Von Klebelsberg found fossil wood on the Schlern plateau (Eastern Alps, Dolomites) at a maximal height of about 2400 meters (50–200 meters above the present tree line) and assumed that these carbonized woods were evidence of a warmer climate of the recent geologic past (R. v. Klebelsberg: Fossiles Holz auf dem Schlernplateau, *Zeitschr. für Gletscherkunde*, Vol. 18, 1930, pp. 233–234). His assumption is that the climate was warmer and at the same time moister. Greater warmth alone would have led to greater dryness, but that could hardly have caused a tree vegetation of such abundance.

the south-southeast. This confirms the view that the grass vegetation is favored by insolation, while tree vegetation at high altitudes is rather favored by moisture.

However, it is remarkable that the tree line on the southern exposure is considerably lower than the normal minimum of the northern exposure, which depends upon the temperature. This effect is shown

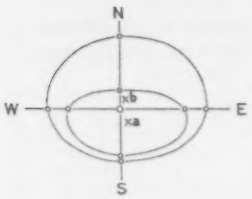

FIG. 1

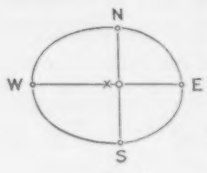

FIG. 2

FIG. 1—Curves of maximum tree and pasture lines derived from mean values of Tables I and II. Taking the center as 2000 meters altitude, 1 mm. equals 17.5 m. for the tree (inner) curve and 70 m. for the pasture (outer) curve. The centers of gravity are marked by a cross, a and b for the tree and pasture curves respectively.

FIG. 2—Curve of maximum heights of alpine economies derived from the mean values of Tables I and II. Taking the center as 2100 meters altitude, 1 mm. equals 5.2 m. The cross indicates the center of gravity.

by the curve, which ascends but very slightly above the east-west line, while the pasture curve ascends very pronouncedly. From the divergence of the two comes therefore the large interval between the two types of vegetation.

It is unnecessary to say that these peculiarities of forest and pasture limits are of great importance to the regional economy of the Alps. It would be of some interest to see how far they parallel conditions in other mountains.

An investigation of the maximal height of the Alpine dairies based on Tables I and II shows that the values for all exposures are quite close together (compare Table IV). The difference between the extremes is only 20 meters—a value only little outside the limit of observational error. However, the altitudes have their significance. The average is only 37 meters higher than the corresponding average of the tree line. From this it may be concluded that the dairies are quite close to the upper tree line. Even the observation from Böverdalen, Norway (Table I, No. 39), is not an exception, because the dairy (the "Pandbergsaeter") is only 35 meters above the tree line.

The ellipse of Figure 2 shows (greatly exaggerated) that its main axis is directed east-westward, like that of the tree-and-pasture curve, but that its center of gravity is the opposite to that of the vegetation curves.

TURBULENCE AND THE TRANSPORTATION OF ROCK DÉBRIS BY STREAMS

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IN the traditional geomorphology discussion of the transport of weathered rock material is organized according to the transporting agents: streams, waves and currents, wind, and glaciers. It appears clearly today that this organization neglects what is perhaps the most important process of all, namely the simple action of gravity on the regolith that forms the surfaces of slopes. If this process is included, a rational classification of modes of transport may be set up, somewhat as follows:

1. Transport of rock débris through its incorporation in masses whose motion resembles laminar flow in highly viscous fluids: (*a*) by gravitational mass movements, and (*b*) by the ice of glaciers.
2. Transport of rock débris through its suspension in turbulent currents of fluids of low viscosity: (*a*) by streams, (*b*) by movements within bodies of "standing" water, and (*c*) by wind.

This grouping recognizes a fundamental physical contrast in the processes of translocation of the products of weathering and is of significance in the interpretation of the forms produced by deposition of the transported material: its implications with reference to assortment of fragments by size, for example, are immediately evident. But much detailed work remains to be done before a doctrinal structure in accordance with it can be erected. The present statement and a recent paper published elsewhere[1] constitute an attempt toward the formulation of a theory of the morphologic activity of streams in line with the scheme presented above.

The fundamental notion itself, that turbulence is responsible for the maintenance of mineral fragments in suspension in water, is not new. Evidently Varenius, writing in the middle of the seventeenth century, already had it in mind when he echoed the opinion of "all physicists" that the omnipresent mixture of foreign matter with water is due to "varia & perpetua particularum [*sc.* aquae] agitatio."[2] Perhaps Varenius acquired the idea, along with many others of his accurate observations on the nature and work of streams, from his contemporaries and neighbors, the Dutch hydraulic engineers. At any rate, hydraulic literature of later date contains the most abundant, though usually perfunctory, references to it, while geomorphologists have paid little attention to the turbulent character of the water of

[1] J. B. Leighly: Toward a Theory of the Morphologic Significance of Turbulence in the Flow of Water in Streams, *Univ. of California Publs. in Geogr.*, Vol. 6, No. 1, Berkeley, 1932, pp. 1–22.
[2] Geographia generalis, Amstelodami, 1650, p. 287.

streams.[3] The concepts of the morphologic work of streams entertained in the United States today are largely those of G. K. Gilbert, who even in the interpretation of his laboratory experiments seems scarcely to have thought of applying the knowledge of turbulence then available.

Discussion of natural streams has generally proceeded from the

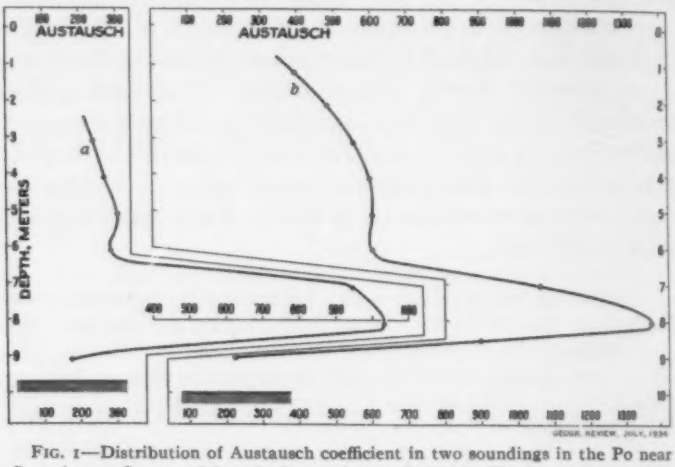

FIG. 1—Distribution of Austausch coefficient in two soundings in the Po near Borgoforte. Computed from hydrometric data in Mario Giandotti: Alcune note sulla dinamica del letto del Po, *Union Géodesique et Géophysique Internationale, Section Internationale d'Hydrologie Scientifique, Bull.* 9, 1927, pp. 5–22 and Pl. 4.

explicit or tacit interpretation of their power to perform geomorphological work as a function of their velocity; but those who have built up the accepted theory have not even evaluated for their purposes the differences in velocity measured within single cross sections of streams. Moreover, the velocity of streams is by no means an independent variable; hydraulic engineers have endeavored for years to find some equation relating velocity to such measurable primary factors as hydraulic gradient, form of cross section of channel, and roughness of bed and have for their pains only a complicated empirical formula that approximately "works." It is true that the ability of a stream to erode its bed and to hold mineral fragments in suspension is related to the velocity distributed unequally through its cross section, but not as effect is related to cause. Both properties are functions of more nearly independent variables, such as gradient and form and area of the cross section. The geomorphologist is not, as the engineer is, primarily interested in the discharge of streams, for the computation of which measurements of velocity are required; he may proceed more directly to his goal by starting with primary factors.

[3] Attention should be directed to two important papers that have appeared since this article was written (November, 1932): Filip Hjulström: Das Transportvermögen der Flüsse und die Bestimmung des Erosionsbetrages, *Geografiska Annaler*, Vol. 14, 1932, pp. 244–258, and M. P. O'Brien: Review of the Theory of Turbulent Flow and Its Relation to Sediment-Transportation, *Trans. Amer. Geophys. Union, Fourteenth Ann. Meeting, April 27, 28, 29, 1933*, Washington, 1933, pp. 487–491.

Students of hydrodynamics have solved a few of the problems raised by the phenomenon of turbulence in fluids: in the paper cited in footnote 1 some of the simpler results of their investigations are applied to streams. A method of computation is described there whereby from familiar hydrometric data—hydraulic gradient and distribution of velocity in the cross section of a stream—the distribution of the intensity of turbulence within the same cross section may be found. The line of argument may be summarized thus:

1. Surfaces of equal velocity in a stream, whose traces in the familiar velocity cross section are isarithms of velocity, are surfaces on which a shear is exerted by the more rapidly moving (active) masses of water upon the more slowly moving (passive) masses. There is thus a flow of force normal to the surfaces of equal velocity, from the most rapidly flowing water toward the more slowly flowing masses, and ultimately to the bed of the stream.

2. If the flow of the water is not accelerated, the shear exerted on any unit area lying in a surface of equal velocity may be computed as a component of the gravitational acceleration (dependent upon the hydraulic gradient) of a prismoidal mass of water whose base is the unit area and whose axis is a line drawn from the unit area, normal to the surfaces of equal velocity, to the point or line of maximum velocity in the cross section. In carrying out the actual computation, dimensions of the unit prismoids are determined by measurement on a drawing of the velocity cross section.

3. The shear exerted on the unit area may also be conceived as the product of the intensity of turbulent interchange through the surface in which the unit area lies and the gradient of velocity across the same surface.

4. If, then, the force computed from the mass of the prismoid and its component of gravitational acceleration is set equal to the product of intensity of turbulence and the local gradient of velocity, the intensity of turbulence at the point dealt with may be computed. Gradient of velocity is easily read graphically from a curve of velocity plotted against distance along lines drawn normal to the isarithms of velocity on the velocity cross section.

The expression used as the measure of the intensity of turbulent mixing is the "Austausch coefficient" of Wilhelm Schmidt.[4] It is this quantity, in c. g. s. units, that is plotted as "Austausch" in Figures 1 and 2 below and, in the paper cited, is exhibited in its distribution through three cross sections of streams.

Distribution of Turbulence in Stream Cross Sections

The curves of Figure 1 represent the variation of the Austausch coefficient along two vertical current-gauge soundings, as computed from measurements made in the deeper parts of the Po near Borgoforte in southeastern Lombardy. Here the Po meanders weakly and at the site of the gauging has a somewhat unsymmetrical cross profile. When the measurements were made, the river was 234 meters wide and had a maximum depth of slightly more than 10 meters. Curve

[4] Wirkungen der ungeordneten Bewegung im Wasser der Meere und Seen, *Annalen der Hydrogr. und Marit. Meteorol.*, Vol. 45, 1917, pp. 367–381 and 431–445. The "dimension" of the Austausch coefficient, in c. g. s. units, is grams per centimeter and second.

a represents a vertical trace located 88 meters from the steeper bank (concave in plan), curve *b* one located 28 meters from the same bank. The maximum of velocity lay between these two soundings, 62 meters from the steeper bank.

Intensity of turbulence, it appears from my computations, is frequently distributed more symmetrically along vertical lines than in the cases represented by the curves of Figure 1; but the curves always display the characteristic maximum within the body of the stream, generally nearer the bed than the surface. From this maximum, turbulence decreases toward zero at the immediate surface and at the bed. When the distribution of intensity of turbulence is represented by isarithms drawn on the plane of a cross section of a stream having a simple channel, two maxima appear, one on each side of the vertical line in which the maximum of velocity lies.[5] The distribution in the deeper parts of the cross section reminds one of two highs connected by a saddle on a map of atmospheric pressure. Curves *a* and *b* of Figure 1 are vertical traces through or near the maxima of turbulence; that nearer the steeper bank is the greater.

This characteristic distribution of intensity of turbulence, as follows from the discussion below, is of prime significance for the configuration of stream channels composed of mobile rock débris. The data available do not at present permit a discussion of the distribution of turbulence in wide and shallow streams. But it appears fairly certain that the behavior of such streams—the formation of multiple channels and mid-channel bars, for example—is an expression of the development of more or less parallel bands of water, in each of which there is a thread constituting a local maximum of velocity. If, as appears probable, each thread of maximum velocity is accompanied by two threads of maximum turbulence, in the manner shown schematically in Figure 6, the distribution of turbulence is complex. Since the distribution of velocity is subject to fluctuation, the channel of a stream that is very wide in relation to its depth cannot possess the relative stability displayed by the channel of one whose breadth and depth have a ratio that allows of but one thread of maximum velocity.

Relation between Turbulence and Turbidity

Except in the case of material so finely divided as to be subject to colloidal dispersion, fragmental rock débris must be at least partly lifted by turbulence from the bed of a stream in order to be moved. Transportation by a stream thus depends upon turbulence in the water among the fragments forming its bed, of an intensity at least sufficient to loosen them, so that the forward thrust of the water, also transmitted

[5] Leighly, *op. cit.*, Figs. 1*b*, 2*b*, and 3*b*. The two maxima are shown schematically in Figure 6 of the present paper.

from the body of the stream by turbulence, may set them in motion. Observation and measurement do not yet permit a quantitative discussion of the processes going on in the entrained layer on the bed. Nevertheless, it seems safe to think of the entrained material as being in a state of imperfect and intermittent suspension, and in that state subject to the same processes as are here described as applying to

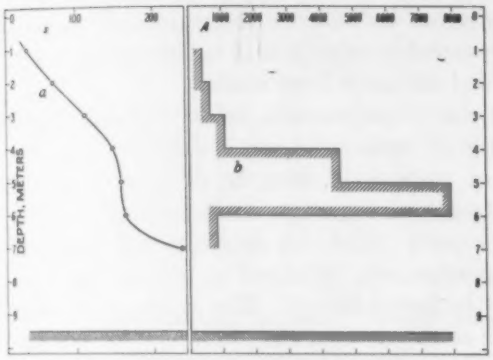

FIG. 2

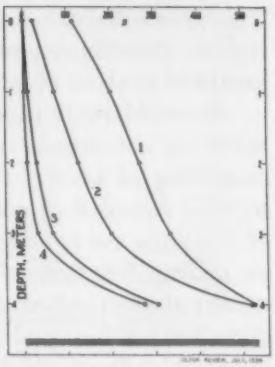

FIG. 3

FIG. 2—Intensity of turbulence computed from suspended sediment in the Nile near the Rosetta barrage. *a*, Vertical distribution of one fraction of suspended sediment; *b*, vertical distribution of Austausch coefficient as computed from *a*.

FIG. 3—Computed vertical distribution of fractions of a complex sample of suspended sediment. Sample collected at the depth marked 3 meters in the figure.

freely suspended particles. Once material is in free mechanical suspension, supported by the turbulence of the fluid medium, its behavior is clear, even to the extent of being amenable to computation. The curves of Figures 2 and 3 display, respectively, the results of computation from amount of suspended matter to intensity of turbulence and from an assumed distribution of turbulence to distribution of suspended matter. The distribution of intensity of turbulence thus found agrees qualitatively with the results of direct computation on the basis of dynamic considerations; and the reflection of the characteristic distribution of turbulence in distribution of suspended matter agrees with direct measurements of turbidity.

The equations used in computing the data plotted in Figures 2 and 3 are presented in the appendix. The fundamental equation defines the relation between the vertical distribution of suspended particles of a given size and density and intensity of turbulence as expressed by Schmidt's Austausch coefficient. Curve *a* of Figure 2 represents the distribution through depth of one fraction of measured sediment, as reported by A. B. Buckley.[6] In curve *b* of the same figure is plotted the distribution of intensity of turbulence through the same column

[6] The Influence of Silt on the Velocity of Water Flowing in Open Channels, *Minutes of Proc. of Instn. of Civil Engineers, London*, Vol. 216, 1923, pp. 183–211; data from table, p. 206.

of water, as computed from the data of curve *a*. The equation used permits the computation of the Austausch coefficient only as a mean through segments of a column of finite length; the length of segment used is the interval at which samples were collected. Though the maximum of intensity of turbulence is much greater than in the curves of Figure 1, the distribution through depth is essentially the same. Thus two independent lines of approach indicate the same distribution. This characteristic distribution of turbulence determines the characteristic distribution of suspended matter found whenever measurements of content of suspended silt have been made.

A considerable range in size of suspensule, below a certain maximum, is the normal quality of suspended silt. Complex samples, consisting of several sizes of suspensule, may be dealt with by the method followed in computing *b* of Figure 2, if the several fractions of a sample are handled separately. For this application I have used an analyzed sample of suspended silt, collected at about 150 centimeters above the bed, from the Sutlej River.[7] The source of the data gives neither the total depth of the river at the point of collection nor information from which the intensity of turbulence may be computed. I have assumed, therefore, a depth of 4.5 meters and, by analogy with the results of other computations, a vertical distribution of the Austausch coefficient as follows:

Depth Zone	0–1	1–2	2–3	3–4 Meters
Austausch	400	800	1000	500

The four fractions separated in the mechanical analysis are defined thus:

Fraction	1	2	3	4
Rate of fall in still water in cm. per sec. . .	2.39	4.57	7.62	10.67
Diameter in mm.	0.15	0.28	0.55	1.00
Amount in suspension at point of collection in g. per 1000 kg.	335	201	67	33

Computing each fraction separately by intervals upward and downward from the point of collection, one gets the distribution of the four fractions shown in Figure 3. Depth 3 meters represents the point of collection. The curves of the figure reproduce in all essentials the results of the few published analyses of suspended silt.[8] The vertical distribution of the several fractions reminds one of the

[7] Reported by T. J. P. Jeffery in *Punjab Irrigation Branch Papers No. 9*, Lahore, 1905, p. 12.

[8] For example, those published by L. G. Straub in *Trans. Amer. Geophys. Union, Thirteenth Ann. Meeting, April 28 and 29, 1932*, Washington, 1932, p. 379.

hypothetical vertical distribution of the gases of the air in a non-turbulent atmosphere, as computed repeatedly from considerations of molecular diffusion of fractions of different atomic weights against gravity. The two phenomena are exact analogues: in the present instance there is mass diffusion through turbulence of fractions having different rates of fall depending on size of suspensule.

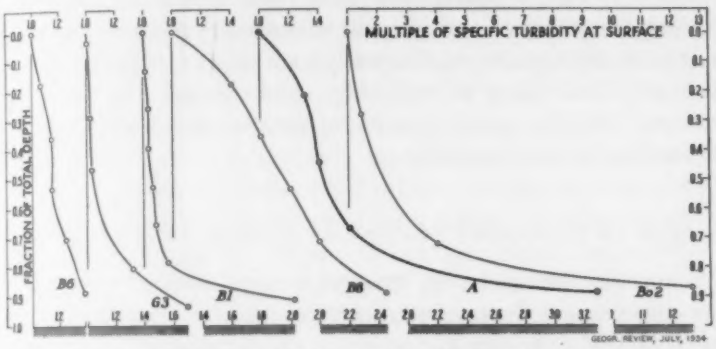

FIG. 4—Specimen curves of vertical distribution of total specific turbidity. Curve *A*, sum of fractions represented in Figure 3. Data for curves *B1*, *B6*, and *B8* from Robert Burton Buckley: Facts, Figures and Formulae for Irrigation Engineers, London, 1908, pp. 54 and 56; for curve *G3* from Grove Karl Gilbert: Hydraulic-Mining Débris in the Sierra Nevada, *U. S. Geol. Survey, Professional Paper 105*, 1917, p. 56; for *Bo2* from Raoul Boissier: Communication in *Archives des Sciences Physiques et Naturelles*, Vol. 41, 1916, p. 332.

The total amount of suspended matter expressed as grams per thousand kilograms (a ratio familiar under the designation "parts per million") may conveniently be called "specific turbidity." In Figure 4 the curve of total specific turbidity (excluding the finest material, discarded in the analysis) of the Sutlej sample, curve *A*, formed by adding the fractions represented in Figure 3, is plotted for comparison with several curves of measured, unanalyzed suspended matter. In order that measurements made in streams that differ widely in depth and turbidity may be more easily compared, specific turbidity at the several depths is computed as the multiple of that measured at the surface, and depth of collection in each instance as its fraction of total depth. The computed curve fits readily into the series based directly on measurement. Minor peculiarities of its form are due to the distribution of intensity of turbulence assumed. By appropriate assumptions, curve *A* might be made to take on the form of any of the curves of the figure.

The forms of the curves other than *A* of Figure 4 are probably affected both by the vertical distribution of turbulence and by the mechanical composition of the sediment in each case. Uniform turbulence through all depths would give an inverse exponential curve. Reference to Figure 3 shows that coarse sediment, the concentration of which changes very rapidly with depth, is distributed in a

manner represented by a curve approaching the exponential form. The two curves *G3* and *Bo2* of Figure 4 are drawn from the data of measurement in streams that carry coarse sediment—the Yuba and the Arve respectively. The presence of fine sediment imposes a form of curve resembling a reversed and elongated *S*. It is obvious that this form is due to the characteristic distribution of intensity of turbulence, with its maximum near mid-depth. The maximum produces an evening of turbidity in the same depth zone; toward the surface from the maximum, decreasing turbulence permits an increasingly rapid diminution of turbidity, and toward the bed reduced turbulence and the concentration of coarse suspensules result in a rapid increase in total turbidity.

Diffusion of Suspended Matter as a Phase of Transportation

All material suspended in streams is simultaneously in movement in the direction of flow. Interpretation of the interaction between water and bed involves the concept of a constant adjustment of suspended load to configuration of bed. Local intensification of turbulence above a minimum determined by the nature of the material forming the bed must cause an increase in the amount of sediment diffused upward, that is in erosion of the bed; diminished turbulence must permit the settling out of a part of what is in suspension, that is, deposition. When the discharge of a stream is constant, equilibrium between intensity of turbulence and configuration of bed must be attained, through the adjustment of gradient at every point by excavation of the bed or by deposition. Significant changes in the channel result from work performed during periods of notable change in mass of water and hydraulic gradient; in other words, during periods of fluctuation of discharge.

The most rapid changes in the beds of permanent streams are due not so much to the movement of sediment downstream as to the lateral components of such movement. Study of the distribution of intensity of turbulence in the cross section provides an insight into the process whereby sediment is shifted laterally and into the changes in the configuration of channels produced by lateral shifting.

Where the course of a stream is straight and the velocity of the water is distributed symmetrically through the cross section, the transverse profile of the bed, in unconsolidated material, resembles the half of a flat ellipse whose major axis is horizontal. Computations reported in the paper cited in footnote 1 show that across the flat part of the bottom of such a stream the intensity of turbulence near the bed is nearly uniform. But the *gradient* of the Austausch coefficient along lines drawn from the bed into the body of the stream varies from point to point across the bed, as does also the maximum of tur-

bulence attained along these lines. The relation of turbulence to turbidity is such that those columns of water in which turbulence at a given distance above the bed is the more intense—i.e. in which the gradient of intensity of turbulence is the greater—will, so to speak, pump upward from the bed more sediment in proportion to their mass of water than will the less turbulent columns. Hence, if the constitution of the bed is such as to allow a part of the material composing it to diffuse upward into suspension, horizontal differences in intensity of turbulence within the cross section will be matched by horizontal differences in specific turbidity. Horizontal gradients of turbidity are set up; and the suspended matter diffuses horizontally in the directions of decreasing turbidity. By such diffusion the suspended matter must come into regions of less intense turbulence than obtained in the columns of water in which it was taken into suspension; into regions in which it cannot be supported in the concentration obtaining in the columns from which it diffuses. Two possibilities for the disposal of this surplus suspended material present themselves:

1. If the mass of less turbulent water into which it diffuses has a greater velocity than the mass from which it comes, it may remain in suspension in the greater mass of water available to it in a given time and, constituting a lower turbidity than in the original columns, be carried on downstream. Hence the middle of a stream with symmetrical distribution of velocity is not filled by deposition from the neighboring, more turbulent, and more turbid regions on each flank, because the middle of the stream is the locus of maximum velocity.

2. If the suspended matter diffuses into water that is slower as well as less turbulent than the columns of maximum turbulence in which it was originally suspended, as toward the sides of a symmetrical channel, it must settle out. Equilibrium in the directions of decreasing velocity *and* decreasing turbulence may be maintained only by a transverse slope of the bed such that the component of gravity along it balances the tendency toward lateral diffusion of sediment. The slope itself may of course be formed in the process of adjustment by the deposition of sediment from suspension. This reasoning provides a basis for the understanding of the general form of stream beds but only opens up the question—not to be pursued further here—of differences in this form consequent upon differences in character of bed material.

On bends, both in model streams and in nature, it has often been observed that mobile débris forming the "apparent" bed (the appellation serving to distinguish it from a "real," because immobile, bed) drifts obliquely across the channel from the "outer" bank (concave in plan) to the "inner" bank (convex in plan). This phenomenon has hitherto been explained by the hypothesis of a rotation of the mass of water within the bend, at the surface toward the outer bank, on the bed toward the inner. The only evidence supporting the hypothesis is the aforementioned cross-channel drift of the material of the apparent bed. A priori, it is scarcely credible that in a turbulent mass of fluid such as forms a stream the several parts of the mass can retain their identity to the extent implied by the hypothesis.

Lateral diffusion of the more or less freely suspended débris that

forms the apparent bed provides an unforced explanation of the transverse drift often observed. Figure 5*a* shows schematically the distribution of intensity of turbulence in the bottom zone of an unsymmetrical stream cross section, and 5*b* the corresponding distribution of turbidity in the same zone. Opposite the point *A* on the bed is the column of maximum gradient of intensity of turbulence normal to

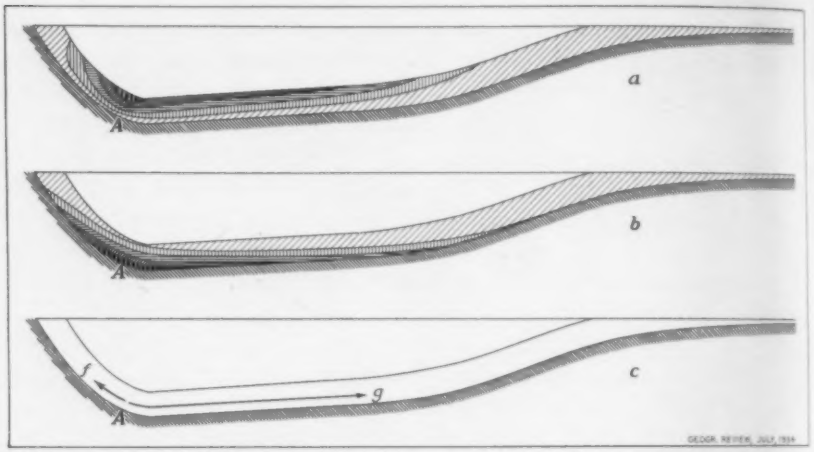

FIG. 5—Conditions determining lateral diffusion of suspended sediment at bends in streams. *a*, Schematic distribution of intensity of turbulence in bottom zone of unsymmetrical stream channel; *b*, distribution of specific turbidity in same zone, corresponding to *a*; *c*, lateral gradients and directions of diffusion of suspended matter in the same zone. Within the zone represented in the drawings distance from the bed is exaggerated.

the bed, and hence of maximum turbidity. Figure 5*c* illustrates the directions of gradients of turbidity in the two transverse directions in which the suspended material tends to diffuse from the column having its base at *A*. In the direction *f*, gravity opposes diffusion parallel to the profile of the steeper bank. In the direction *g*, the material diffused from the column of maximum turbidity is either disposed of by the greater velocity of the water in the deepest parts of the stream or is deposited, after migrating obliquely across the bottom, to form the bank that rises to the right of *g* in the figure.

Figure 6 is a generalization, on the basis of evidence now available, of the locations of maxima of turbulence and velocity in stream cross sections. The regions of the cross sections separated by broken lines and designated by Roman numerals apply particularly to the bottom zone, where most of the suspended material is carried, and from which it is deposited. The regions may be characterized thus:

REGION	TURBULENCE	VELOCITY
I. Axial	Moderate	High
II. Flanking	High	Moderate
III. Lateral	Low	Low

My own direct observations, made on small streams under favor-

able conditions, show that regions II are the most turbid parts of the cross section. The directions of most active diffusion of suspended matter, indicated by the arrows of Figure 6, are drawn in accordance with gradients of turbidity; diffusion in these directions accounts for the maintenance of symmetrical channels and for the continuous changes that follow normally from asymmetry of cross profile. Regions I and II must always be present where there is a local thread of maximum velocity; regions III may be of indefinite extent laterally

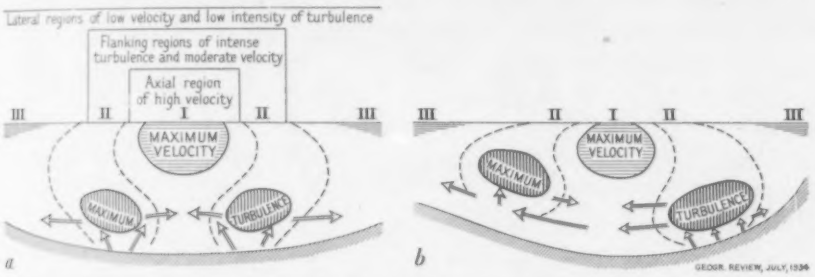

FIG. 6—Schematic representation of the relation between maxima of turbulence and of velocity in cross sections of streams having *a*, symmetrical, *b*, unsymmetrical transverse profiles. Principal directions of diffusion of suspended matter are indicated by arrows. The broken lines show the approximate boundaries of "regions" I, II, and III, defined in *a* and in the text.

and may include all areas of quiet water continuous with the main line of flow and having any one of many possible relations to the main current. Their relation to the axial region may be, for example, that of the quieter sides of a stream, of the mass of quiet water of a lake or bay into which the stream debouches, or of water backed up into a tributary at flood stage. It is the region of deposition of suspended matter diffused from the regions of maximum turbulence and turbidity.

All stream deposits are formed in areas that are lateral to some thread of maximum velocity and its flanking threads of maximum turbulence. Examples suggest themselves: natural levees and their underwater extensions in deltas, and the main bodies of deltas formed laterally from the channels kept open by the axial currents of debouching streams. The filling up of *both* ends of a cut-off meander presents difficulties to the traditional explanation of deposition as the result of decrease in velocity: plainly the water of the silt-bearing main stream cannot flow into *both* ends of the cut-off segment, to deposit its burden of sediment when its velocity is checked. But both ends, as long as they are continuous with the main body of the stream, are to an equal degree parts of region III of the entire mass of water and so are loci of deposition from suspension.

Diffusion into lateral regions may even take place against a current and the deposition of the diffused material give rise to forms inexplicable in terms of the traditional conception. I once saw, at the mouth of Bright Angel Creek at the bottom of the Grand Canyon, a deposi-

tional form unknown to the literature of fluvial morphology, which I tentatively dubbed at the time a "reverse delta." At high water in the Colorado the lower course of Bright Angel Creek had been filled with relatively quiet water, maintained by the clear water of the creek at a much lower turbidity than obtained in the Colorado. Sand from the Colorado had diffused into this less turbid pocket and, under conditions of less intense turbulence than obtained in the main stream, had settled out in foreset beds dipping sharply in a direction opposite to the flow of Bright Angel Creek. At the lower water stage at which the "reverse delta" was observed the smaller stream was busy washing the sand back into the Colorado and clearly exposing its stratification.

Appendix: Computation of Data Presented in Figures 2 and 3

The relation between turbulence and the distribution of suspended matter in equilibrium in a column of fluid is expressed by the following equation, derived by Wilhelm Schmidt:[9]

$$s_z = s_o . e^{-\frac{c}{A} z}. \qquad (1)$$

In the equation, s_o is the specific turbidity at the base of the column and s_z the specific turbidity at the height z above the base; c is the rate of fall of the suspensules in the suspending fluid when it is non-turbulent, A the Austausch coefficient in the column between the base and the height z, and e the base of natural logarithms. In the computations, z was expressed in centimeters, and c in centimeters per second. The base of the column may of course be taken at any height; each size of suspensule must be handled separately. The vertical distribution of the fractions represented in Figure 3 was computed directly by this equation, working by finite intervals upward and downward from the point of collection.

In order to be used for the computation of the Austausch coefficient from the data of turbidity measurements, equation (1) must be solved for A; it then becomes

$$A = \frac{cz}{log_e \frac{s_o}{s_z}}. \qquad (2)$$

Since the equation gives only a mean value of Austausch between the limits of the segment of the column used in the computation, the results in *b* of Figure 2 are discontinuous. The sample used in the computation of the curve was analyzed into only three fractions, which Buckley denominated respectively "coarse sand," "fine sand," and "fine silt and clay." Only the second fraction had a sufficiently small range of size to be of use in the computation: it "passed a 100 sieve but was caught on a 200 sieve." To it I assigned a representative diameter of 0.1 millimeters and a rate of fall of 3.1 centimeters per second.

In the computation of the data plotted in both Figures 2 and 3 the relation between size of particle and rate of fall in still water is defined by the formula

$$c = 7.72 \sqrt{D(d-1)}, \qquad (3)$$

in which c is the rate of fall in centimeters per second, D the diameter of the particle in millimeters, and d its density, taken as 2.6. It is recomputed as to units from a formula developed in an old work on ore dressing;[10] I have used it in preference to the better known formula of Stokes, because it was devised specifically for particles of irregular shape, while the Stokes formula depends for its validity upon spherical form of particles.

[9] Der Massenaustausch in freier Luft und verwandte Erscheinungen (Probleme der kosmischen Physik, 7), Hamburg, 1925, p. 62.

[10] P. von Rittinger: Lehrbuch der Aufbereitungskunde, Berlin, 1867, p. 191.

FURTHER EXPLORATIONS IN EAST GREENLAND, 1933*

Louise A. Boyd

A land remarkable for the splendid dignity of its scenery and possessed of a subtle power of inspiring affection tempered by a sense of awe.

A. C. Seward: A Summer in Greenland.

MY second expedition[1] to East Greenland was for the study of certain elements of its remarkable scenery, particularly the fiords and glacial marginal features. The Danish and Norwegian expeditions had practically completed the exploratory survey of the region; we, therefore, planned to map small, critically selected areas in detail, using a Wild phototheodolite. To the best of my knowledge we were the first American expedition equipped to undertake ground photogrammetrical survey. Five localities, including the whole of the Gregory Valley, Frænkel Land, were mapped by this means.

The scientific personnel of the expedition included O. M. Miller, of the American Geographical Society, surveyor; Walter A. Wood, Jr., assistant surveyor; J Harlen Bretz, of the University of Chicago, physiographer; William B. Drew, of the Gray Herbarium, botanist; N. E. Odell, of Cambridge, England, geologist; and myself, leader and official photographer.

Jan Mayen and the Greenland Pack Ice

The expedition sailed from Aalesund, Norway, June 28, 1933, on the *Veslekari*. Before leaving Norwegian waters, however, we had to test the self-recording echo sounder installed primarily for running cross sections of the fiords. An instrument such as could be installed on a vessel of the type of the *Veslekari* had never recorded a greater depth than 750 fathoms: to record depths of 1000 fathoms, as seemed needful, certain changes had to be introduced. We journeyed northward along the coast to the Lofoten-Vesteraalen Islands, where the test was made to our satisfaction—at 1200 fathoms, a greater depth than previously recorded with such an instrument, it was still recording strongly. We returned to Harstad to put off the two echo-sounding engineers and then set our course for Jan Mayen, which was reached after a rough voyage of four days. On this occasion we found the small group of men who maintain the meteorological

*A full report of the expedition and its findings, now under preparation, will appear as a Special Publication of the American Geographical Society.

[1] See L. A. Boyd: Fiords of East Greenland: A Photographic Reconnaissance throughout the Franz Josef and King Oscar Fiords, *Geogr. Rev.*, Vol. 22, 1932, pp. 529–561.

station for the Norwegian government augmented by three Austrians, with their own meteorological station. Austria had sent her men to Jan Mayen the first Polar Year, 1882–1883. The winter of 1932–1933 was the second International Polar Year, and she sent them again.

Here, unfortunately, Mr. Drew, our botanist, was stricken with appendicitis and was transferred to a Norwegian whaler for transportation back to Norway. As we departed from Jan Mayen, July 11, bad weather set in and obliterated all view of Mt. Beerenberg in its "regal splendour."

The pack ice encountered on the route to East Greenland is generally difficult to cross; its width varies from year to year, but in normal times one can expect it to be from 100 to 150 miles wide, and from ten days to two or more weeks are required for the crossing. This year the pack was exceedingly open: we were able to find waterways through its entire width of 139 miles, which we crossed in 19 hours. Only 36 hours after leaving Jan Mayen Island we were off Hold With Hope, and in 42 hours we had dropped anchor at Myggbukta, on Mackenzie Bay.

Among other scientific instruments with which the expedition was equipped were two automatic tide gauges kindly lent us by the United States Coast and Geodetic Survey. One of these we set up on Tern Island, in Mackenzie Bay, a small, low island not far from the wireless station, so named because it is the breeding ground of thousands of terns.

This task had barely been completed when a hydroplane appeared and alighted alongside our ship. It was Dr. Lauge Koch, the famous Arctic explorer and the Danish representative on the East Coast of Greenland. He gave us a hearty welcome to East Greenland and very kindly informed us that from the air all the fiords were observed to be solidly closed by very heavy ice. Unable to start work as planned, we went to Bonteko Island and then north as far as Arundel Island, off the northeastern part of Hold With Hope, where heavy polar ice was encountered.

Into the Fiords

By July 23 ice conditions had changed, and we were able to enter Franz Josef Fiord, now free of all ice except icebergs. At the request of Professor Bretz a photogrammetrical map was made of a delta on the north side of this fiord on Gauss Peninsula, not far from Cape Franklin.

Continuing inward, we passed Cape Weber at the mouth of Geologist Fiord. The narrow part of Franz Josef Fiord, whose canyon-like walls increase in height and vividness of color, was now entered. In front of us loomed the "Teufelsschloss." We anchored opposite

FIG. 1—Towering spires of ice in Kjerulf Fiord. Perfect reflection in the stillness of the fiord waters gives them an exaggerated height. August 6, 1933.

at Blomsterbugten, Ymer Island. Here we remained three and a half days, and here we set up our second tide gauge.

Ice Fiord, well named for the giant icebergs that habitually block its entire length of 15 miles, was our next objective. Anchorage for the night was made in Renbukten, the only bay on the north side of this fiord. Until 1931 the inner end of Ice Fiord had never been visited

FIG. 2—Map showing the Franz Josef Fiord region of East Greenland and the scene of the activities of the expedition. Scale 1 : 3,100,000.

by a ship, and the map delineations made from distant observations were inaccurate. On my expedition of that year the head of the fiord was mapped, and this, I suppose, is the reason for the honor Dr. Koch has done me in applying my name to the land thereabouts. On this land, facing eastward, is the Louise Glacier. It was decided to make a photogrammetrical map and photographic studies of its snout. Camp was established on the south side, close to the glacier, at an elevation of 1600 feet.

On August 5 we proceeded to the inner end of Franz Josef Fiord, thus rounding the Frænkel Land peninsula. Mt. Ättestupan, which marks the southeastern corner of the peninsula and causes a sharp bend in the fiord, was so named by Nathorst in 1899 as symbolic of the legend that the Vikings of old overtaken by old age or illness threw themselves from the top of a lofty precipice. The face of Ättestupan drops almost perpendicularly from a summit of over 6000 feet to the water level of this fiord.

RECONNAISSANCE IN KJERULF FIORD

We had now reached the region in which we were to do our principal work. Before us lay the choice of going southwestward—following the Hisinger Glacier to the western part of Goodenough

Land and Mt. Shackleton—or of crossing Frænkel Land and endeavoring to reach the Mystery Lakes and Jätte Glacier, seen by Mr. Wordie from the summit of Petermann Peak in 1929.[2] Preliminary reconnaissance was necessary. This we carried out on August 6. While the rest of the party went north to Frænkel Land, I myself, accompanied by Captain Olsen, went southward to familiar ground at the head of Kjerulf Fiord.

As on my 1931 trip, it proved impossible to take the ship beyond the entrance of Kjerulf, the only southward-penetrating arm of Franz Josef Fiord, because of the number and size of icebergs blocking its entire length of about 9 miles. The origin of these icebergs was something of a mystery, for no glacier descends to the head of Kjerulf Fiord, nor do any descend its sides to water level: it did not seem possible that they could come from the near-by Nordenskiöld Glacier, which fills the inner end of Franz Josef Fiord. On my 1931 trip I felt convinced that they were carried from Ice Fiord by wind and tide. We now were afforded proof in point. We saw a large berg come out of Ice Fiord, round its western point, and continue to Kjerulf. This fiord is a veritable graveyard for icebergs. Throughout its length a tally of only the larger ones totaled over 400. Little space was left between them and the shore. Their heights ranged up to 100 or more feet. These icebergs, majestic in height and size, give an impression of permanence and durability—a thought that is soon dispelled, however. A booming sound, reverberating through the fiord, foretells their doom. An instant later what had seemed so indestructible is now a shattered mass of broken ice.

The trip up Kjerulf Fiord had been made by motor launch: on returning to the launch, one of the crew found close to the water's edge a sealed bottle containing a note. It proved to be a message, written in both Swedish and English, from the chief surgeon of the Swedish expedition of 1899, which went to East Greenland in search of the lost balloonists, Andrée, Strindberg, and Frænkel. It read:

> This point, the inmost of Frans Josefs Inlet I have reached at the 12 aug. 1899, alone on a canoe. Dr. Josef Hammar The Swedish Greenlandsexpedition, 1899. Surgeon on Antarctic.

The Gregory Valley

The result of the reconnaissance trip was a definite decision in favor of Frænkel Land. Preparations for a sojourn of three to four weeks were now made, and August 10 the party was ready to start. Our route lay along the western side of what we call the lower Gregory Valley, a rocky valley terminating in a stony and boulder-strewn delta on the north side of Franz Josef Fiord, near the inner end.

[2] J. M. Wordie: Cambridge East Greenland Expedition, 1929: Ascent of Petermann Peak, *Geogr. Journ.*, Vol. 75, 1930, pp. 481–504.

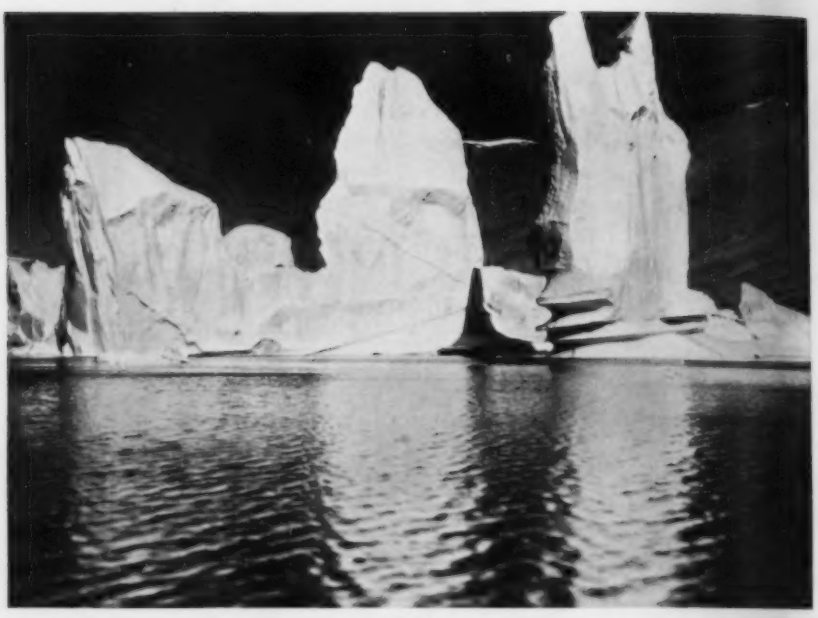

FIG. 3

FIG. 4

FIG. 3—Ice giants in Kjerulf Fiord. An illustration of the architectural quality frequently displayed by the bergs. August 6, 1933.

FIG. 4—Iceberg at the head of Ice Fiord showing dirt bands. August 3, 1933.

FIG. 5

FIG. 6

FIG. 5—The eastern wall (Suess Land) of Kjerulf Fiord and some of the large bergs in this veritable graveyard of icebergs. August 6, 1933.

FIG. 6—Close up of tabular iceberg with caves, pinnacles, and dirt bands. Ice Fiord near Renbukten. July 30, 1933.

FIG. 7—Cascade descending the north wall (Frænkel Land) of Franz Josef Fiord just west of Ättestupan, from a height of more than 5000 feet. The *Veslekari* is passing well in front of a large iceberg at the base. August 5, 1933.

Four miles up the valley we came to the junction of valleys from the west and the north. The latter was completely filled with a triple glacier, which suggested the name Trident that we bestowed upon it. The snout of Trident Glacier shows débris in the basal ice; longitudinal, melting furrows on the surface; and a large, recently abandoned moraine. Crossing part of the moraine, we proceeded up a gorgelike portion of the western valley. On the steep shoulder of its northern side we made our first camp, at an elevation of 2100 feet. Vegetation was sparse, but dried roots of the willow provided us with firewood in sufficiency. A small spring supplied water. The chilly nights caused a thin layer of ice to form over this by the morning. At the western end of the gorge a glacier descended from the summit of the south wall to the floor. Under its arched snout—whence the name Arch Glacier—pass the entire waters of the stream from upper Gregory Valley. Arch Glacier in reality consists of two glaciers that join near the summit and descend as one, yet the ice of each remains separate throughout their length—they never mix. Opposite the snout of Arch Glacier sand blown by the wind extended upward on the rocky ledges of the north side, several hundred feet above stream level. About 200 feet above the stream level was the uppermost outlet of the old Gregory Lake showing the remnant of the oldest moraine

of the Arch Glacier with lakelet. The western moraine of Arch Glacier dammed a mud flat through which the Gregory stream had cut a passage. There existed shore lines on the talus on the south wall, just to the west of the moraine of Arch Glacier. For several miles farther up the valley, above the head of the gorgelike portion, the floor is a broad, sandy flat with braided stream. At the western end of the flat was a huge moraine, like a dam across the valley, through which the stream had cut its way. Not far from this gateway moraine was a terrace of lake silt at the base of the talus. This part of the valley has, in reality, two gateways—one in the east, formed by Arch Glacier and its moraine, and one in the west, formed by another moraine, but without a glacier—so that the stream has had to cut its way through both. The ponding, which is recorded by the old shore lines and the silt terraces, was largely confined to the stretch between the two morainal dams.

FIG. 8—Glacier on the north wall of Gregory Valley at Camp 2. Huge moraines mark its former extension. August 19, 1933.

Our second camp was made four and a half miles west of Camp 1, close to the water's edge on a sandy terrace on which were numerous avalanche boulders. We had no material for firewood here; cooking was done with petrol on primus stoves. The high walls deprived us of the sun except for a few hours in the day. There was a noticeable difference in the quantity of water descending this valley. In the early morning the braided stream was easy to cross, but in the afternoon, after the sun had been shining on its frozen sources at the head

FIG. 9

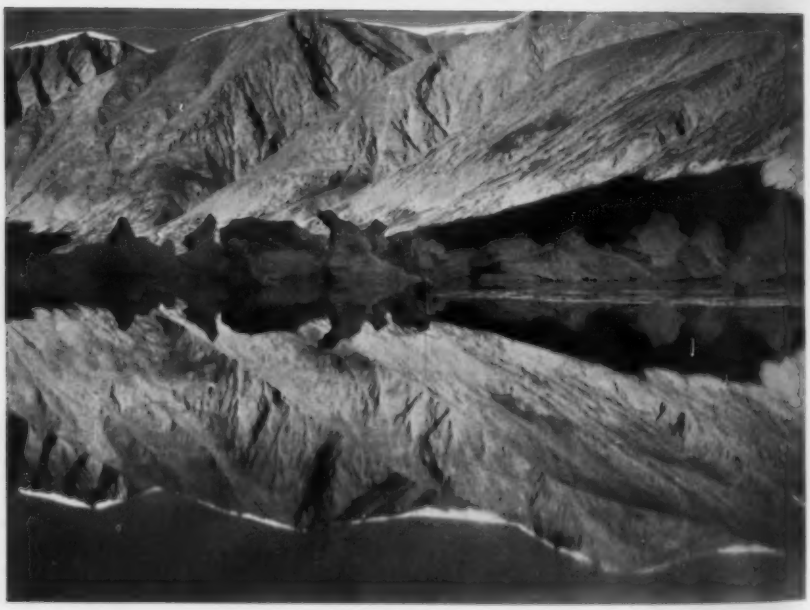

FIG. 10

FIG. 9—The head of Ice Fiord, Miss Boyd Land. The south side of Louise Glacier is in the foreground and the dissected plateau of Frænkel Land in the background. August 2, 1933.

FIG. 10—The head of Kjerulf Fiord. Icebergs in massed formation are stranded on the mud flats the entire width of the fiord. Reflections of the bergs formed fantastic silhouettes against the deep black shadows in the fiord at 7.30 p. m. August 6, 1933.

FIG. 11

FIG. 12

FIG. 11—The western end of Gregory Valley and Gregory Glacier from Camp 3. This is the headwater of the stream that flows into Franz Josef Fiord close to Nordenskiöld Glacier. August 18, 1933.

FIG. 12—The lower of the two "mystery" lakes on the north side of Frænkel Land with the Jätte Glacier, completely filling the valley, and Miss Boyd Land in the background. Icebergs calve off the side of Jätte Glacier into this lake and large stranded bergs are seen on the shore many feet from the present water level. August 17, 1933.

of the valley, the stream rose and was several feet higher in the afternoon and evening. There was always a chill in the air at this camp, which was increased by a current of wind that formed a draft through these gateways.

Going farther west, we made Camp 3 in a wide part of the valley—the "Upper Gregory Valley," as we called it. Not far from our third camp were sand dunes on which grew grasses and the willow, bright yellow in color and two or more feet in height. On the north side of the valley were dry stream beds. These were ablaze with the autumn colors of the bilberry, resembling our blueberries and delicious to eat, the crowberry, with its deep green foliage, and a blackberry; with the brilliant, fiery red of the bearberry and the red and yellow of the dwarf birch.

The Mystery Lakes

The head of the Upper Gregory Valley lies at the foot and to the east of the line of peaks running north from Petermann Peak. The latter is 9650 feet high, the highest peak in this part of Greenland. The source of the stream we had followed all the way from the fiord is the large Gregory Glacier, which flows north from the neighborhood of Petermann Peak itself. Here I had my first view of the side valley that lies between the snout of Gregory Glacier and the Jätte Glacier and that contains the mystery lakes—mysterious no longer. The northern end of this side valley is blocked by the Jätte Glacier, sweeping by from the ice cap to Ice Fiord.

A low watershed lies halfway along this valley, so that some of the drainage is to the south into the Gregory Valley and the rest back into the Jätte Glacier. The northern half of this valley contains the two "mystery lakes." The larger of the two, which is the lower, is actually terminated by the side of the Jätte Glacier, and ice calves from the latter into the lake. On its western shore many feet above the water's edge were large stranded icebergs. How long these bergs have been stranded on dry land and how old they are are problems for the scientists to solve. However, the maximum height to which this lake had risen was clearly shown by an abandoned shore line all the way round the lake. Jätte Glacier as seen from the upper end of the Mystery Valley carries with it a large lateral moraine and also a medial moraine. We had now crossed Frænkel Land and were alongside the Jätte Glacier many miles inland from where it enters Ice Fiord. To the north we could see Miss Boyd Land, a mass of peaks with glaciers descending wholly or part way into the main stream of ice.

Departure and Return Journey

On August 26 a definite change occurred in the weather: days of sunshine were now replaced by thick fog followed by heavy clouds,

making visibility of the fiord summits rare and of short duration. Departure was becoming imperative. By August 28 all members of the expedition had returned. One day, August 30, was spent in crossing from Kjerulf Fiord to Dickson Fiord.

Before leaving the fiord region, however, it was decided to spend a day in Geologist Fiord, which had special interest for Mr. Odell and Professor Bretz. The inner end is filled by the large Nunatak Glacier. Close to its face our soundings showed a depth of 120 fathoms. We found good anchorage for the night a short distance from here and the next morning landed the scientists on the southwest side of the glacier.

September 5, blessed by brilliant sunshine, we spent in Musk-ox Fiord. The snows of the preceding days had formed a regular line of demarcation on both sides of the fiord, below which the vegetation was ablaze with brilliant red hues.

We now had to leave the fiords. It was late in the season, and we had no ice reports. On September 6 our homeward journey was begun. Off the entrance to Franz Josef Fiord we ran into a gale of such severity that it was necessary to put back to Myggbukta and await a better start. Early on September 8 the *Veslekari* put out to sea again, only to encounter a still worse gale, the wind this time reaching a velocity of 55 miles an hour and accompanied by a blinding snowstorm. For the second time we reëntered Myggbukta. Nature was closing her doors on East Greenland!

The next day, however, September 9, under favorable circumstances, we passed out of Mackenzie Bay and through a narrow strip of small and open ice. With Hold With Hope on our port side covered with snow, we left Greenland in her winter mantle. In a record time of 4 days and 2 hours we reached the southernmost point of the Lofoten Islands, Norway, having passed through the Greenland Sea in open water, totally devoid of any kind of ice, even an iceberg—a most unusual condition. September 16 the *Veslekari* docked at Aalesund and the expedition terminated its voyage of 80 days, 60 of which had actually been spent in Greenland.

THE SIERRA NEVADA DE SANTA MARTA*

AN ASCENT FROM THE NORTH

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THE Sierra Nevada de Santa Marta has been singularly neglected. Practically all the accurate information we have about this mountain massif has been assembled in the last decade. Even so fundamental a fact as its height has not been definitely established: the figures given range between 18,000 and 21,000 feet. Until now no plants had been collected above 14,000 feet. Yet the snow-capped summits of the Sierra are only 25 miles distant from a readily accessible coast. In

FIG. 1—Map of the Sierra Nevada de Santa Marta showing the author's route.

1931 Griffith Taylor made an ascent of the western slopes: he described his observations under the title of "Settlement Zones of the Sierra Nevada de Santa Marta, Colombia."[1] In 1932 the writer made a geobotanical excursion into the massif from the north: he here gives an account of the zonal distributions on the northern slopes. The western route has also been used by Mason[2] and Cabot,[3] the northern trail by Carriker,[4] Wollaston,[5] and, in part, by De Brettes.[6]

The best time of year for a visit to the Sierra Nevada is determined by one's interest. For alpine climbing and distant views the dry and clear season, from January to March, is the better. For biological study the early part of the rainy season, when plant and animal life are at their best, is preferable. On the northern slope, east of Santa Marta, there is a lull in the rainy season during late June and July, the "verano de San Juan," of which it is well to take advantage.

*I wish to express my gratitude for the courteous hospitality and material assistance of their Excellencies, Don Miguel A. Zuniga, Acting Governor of the Province of Magdalena, and Don Manuel Julián de Mier, Mayor of Santa Marta. I am also indebted to Mr. Ellsworth Killip, of the United States National Museum, for the identification of many of the plants collected.

[1] *Geogr. Rev.*, Vol. 21, 1931, pp. 539–558.

[2] J. A. Mason: Archaeology of Santa Marta, Colombia: The Tairona Culture, *Field Museum of Nat. Hist. Publ. 304 (Anthropol. Ser., Vol. 20, No. 1)*, Chicago, 1931.

[3] T. D. Cabot: Mountains of the Caribbean, *Appalachia*, Vol. 18, 1930–1931, pp. 17–22.

[4] W. E. C. Todd and M. A. Carriker, Jr.: The Birds of the Santa Marta Region of Colombia: A Study in Altitudinal Distribution, *Annals Carnegie Museum*, Vol. 14, 1922, pp. 3–611.

[5] A. F. R. Wollaston: The Sierra Nevada of Santa Marta, Colombia, *Geogr. Journ.*, Vol. 66, 1925, pp. 97–111.

[6] Joseph de Brettes: Chez les Indiens du Nord de la Colombie, *Le Tour du Monde*, Vol. 4 (N.S.), 1898, pp. 61–96 and 433–480.

FIG. 2—A street in Dibulla, with coconut palms.

The narrative of our ascent of the mountains begins at Dibulla (Fig. 2), a hot, malaria-infested negro settlement 60 miles east of Santa Marta. The trail follows the shore for some five miles westward, passing one of the few coconut plantations of the region, the coastal vegetation otherwise consisting almost wholly of the low tree *Coccoloba* (sea grape). The trail then turns inland across the plain where all of the discomforts of travel in the tropics seem to be combined—insects, heat, dust, marshes, and the absence of drinking water. It is, however, by no means without interest for the naturalist, for here, in the xerophytic coastal zone, is the home of the palmiche palm (*Euterpe*), the giant cactus (*Cephalocereus*), the sprawling calabash tree (*Crescentia*), which is so typical of Caribbean shores, and the bottle tree (*Sterculia rupestris*), with its bulging trunk. Taylor refers to this last-mentioned tree as very characteristic of the somewhat higher xerophytic zone on the west slope.

THE LOWLAND FOREST

Ten to twelve miles from the shore bring one to the edge of the lowland forest. Here, in clearings near the site of the ancient village of Bongá, the natives have their garden patches—plantain, corn, and yuca; banana, papaya, and pineapple. The

FIG. 3—A street in Pueblo Viejo, with broad-leaved plaintain "trees."

forest begins at an altitude of about 300 feet. It represents the finest plant association that the tropics have to offer. The trunks of the giant caracolí (*Anacardium*), higueron (*Ficus*), and guayabo (*Eugenia*) rise in the air to 150 feet. From their uppermost limbs swing the larger lianas, among them the sinuous air roots of young "strangling" figs. Every limb has its quota of epiphytes, mostly bromeliads, and with them orchids and pendent ferns. The forest floor is covered with the brilliantly flowered *Heliconia* (the so-called wild plantain), aroids, especially the perforate-leaved *Monstera* and the renowned South American genus *Anthurium*, small palms (*Chamaedorea*), and the fantastic, white, spider-like flower of *Hymenocallis*. Through this luxuriant tropical vegetation the Indians of pre-Columbian times cut a broad roadway, which still exists, giving a superb vista into the forest. As the trail leads upward, there occur in abundance the fruits of the avocado.

FIG. 4—The patriarch of the Arhuacos.

At an altitude of 2000 feet a marked change in plant life takes place. The huge lowland trees are now rare—they continue to greater heights on the western slopes of the Sierra—and the vegetation in general is sparser. New forms appear, among them the tree fern and the climbing bamboo, certain species of which have the extraordinary habit of flowering but once in their lifetime of 32 years. Terrestrial orchids of great beauty, rivaling the epiphytic ones, are numerous in the grassy fields here and at higher altitudes.

THE NEGRO VILLAGE OF PUEBLO VIEJO

The trail proceeds to the negro village of Pueblo Viejo (Fig. 3), at an altitude of 2800 feet. In spite of its name the hamlet is relatively new, replacing the now extinct village of San Antonio, the disappearance of which is variously ascribed to destruction by Colombian soldiers during the last revolution or by *civilizados* who drove out the inhabitants or by fires set by the Indians in retaliation against the blacks. Living conditions at Pueblo Viejo are no better than on the coast from the point of view of accommodations, but climate and surroundings are more agreeable. The village, though in itself unattractive, nestles among grass-covered hills dominated by the precipitous Cerro Nanú. The higher altitude, with its cool nights and abundant rainfall, adds greatly to the health of the people and to the luxuriance of plant life. Bananas and plantains reach a huge size, with stalks 15 feet high and a foot in diameter. Sugar cane is a prolific grower. The natives are less diseased, and the pigs are fatter. Two valuable additions to the food supply are to be found here—milk and oranges.

As far as climate and soil are concerned, Pueblo Viejo is a region that could be

agriculturally developed with success. Almost any type of crop that flourishes in the tropics or subtropics could be grown. The cultivated plants now to be found there include oranges, bananas, plantains, sugar cane, cotton, tobacco, onions, cabbages, arracacha (*Conium arracacha*), potatoes, beans, and yams. The oranges gathered at San Francisco near by proved to be sweet and juicy. Apples and tomatoes could undoubtedly be grown with equal success. Coffee is not raised but is grown in quantity in identical regions elsewhere in the Sierra Nevada. Life at Pueblo Viejo would, under good living conditions, be comparable to that at the haciendas above Santa Marta at the same altitude. Furthermore, the northern slopes of the Sierra Nevada are watered by permanent streams —a natural and easily applied source for power and irrigation.

Several trails lead out of Pueblo Viejo, one of them to San Francisco, the first of the few Arhuaco Indian villages. The facial characteristics of the inhabitants here and also the square houses indicate Spanish influence. Another trail leads west to the Indian village of Palomino, and yet another south to San Miguel, the highest of the Indian settlements. It is the last-named route that we shall travel. The trail rises rapidly, crosses a steep divide, and then descends to the Río Ancho. Simons, on his map,[7] shows San Miguel west and somewhat north of Pueblo Viejo, but this is an error; it lies to the southwest.

FIG. 5—A *cansamaria*, or native temple, at Macotama. The Indians are chewing coca leaves, handling their *suigis* or gourds containing lime.

SAN MIGUEL AND THE ARHUACOS

About two hours out of Pueblo Viejo a group of several Indian huts, known as Santa Cruz, is passed. Another four or five hours, through open and mostly treeless country, bring one to San Miguel, at an altitude of 5260 feet. The first in the series of impressive approaches to the village is a bridge built of poles and woven cane stalks, spanning the deep ravine above which lies San Miguel, well protected from attack. This gorge proved to be unusually rich in ferns. The bridge leads directly to a pre-Columbian megalithic stone stairway, now much disarranged. Beyond the stairway lies the temple yard. It reveals a feeling for order—a trait lacking in the coastal negroes. On the grounds are several circular huts, two with the characteristic tops that indicate the religious function of the buildings. The whole is surrounded by a

[7] F. A. A. Simons: On the Sierra Nevada of Santa Marta and Its Watershed, *Proc. Royal Geogr. Soc.*, Vol. 3 (N.S.), 1881, pp. 705–723.

planting of *Fourcroya*, a stiff-leaved plant closely related to and very much resembling the agave, which serves the Indian as a source of fiber for rope, bags, and the like.

A few minutes from the temple grounds bring one to the village proper, with its small and artistic portal, a kind of lich gate (Fig. 6)—further evidence of the Indian's love of seclusion and beauty. Immediately beyond lies the village, hemmed in by high mountain ridges and resting on a small plateau just a mile above the sea. Some sixty or seventy huts grouped closely together with neat open spaces between them constitute the village of San Miguel (Fig. 7)—room enough to house fully a hundred

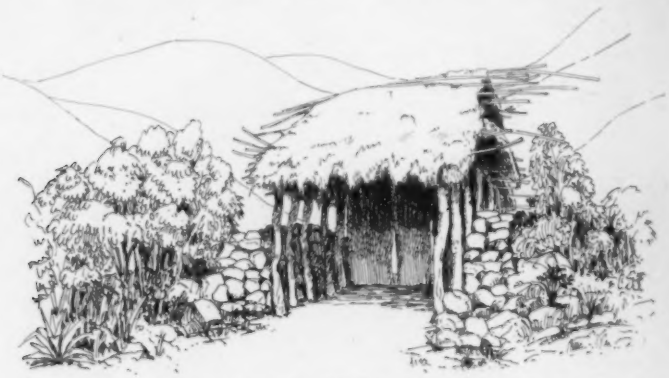

FIG. 6—The entrance gate to San Miguel. (Drawn from a photograph by E. W. Emmart.)

people, yet when we entered not a person was in sight. The village is used only as a gathering place. Every Indian has his one, two, or three small farms some distance away, where he has built himself a hut as comfortable as the one he owns in town. Here he goes with his wife, children, pigs, chickens, and dog to care for first one crop and then the next. In the higher altitudes he grazes his cattle and plants potatoes and arracacha. Near the village, or slightly lower, plaintains, sugar cane, corn, cotton, coca, and tobacco are grown. In the hot lowlands he raises yuca, bananas, and some few other fruits, though it is the negro who enjoys the pine-apple and papaya more.

The houses of San Miguel are of several types, each serving a different purpose. The commonest are the small circular ones of mud. When a man is young, he builds himself a hut. On marrying, he builds a second one opposite and close by, for his wife and children. The family eats outdoors between the two huts, or the husband takes his meal to the men's hut. This latter is a large structure with walls of plaited cane instead of mud. The religious houses possess a specially constructed apical ornamentation the character of which indicates the precise use to which the temple or *cansamaria* is put—for novitiate, priest, or high priest. Finally, there are the square houses for foreigners or for purposes that are foreign to the life of the Indian, as is, for example, the Catholic church, opened once a year when the priest pays his annual visit.

The Arhuacos differ markedly from the coastal Goajiras, their nearest aboriginal neighbors, both in appearance and in character. Mason[8] contrasts the two tribes as follows: the Goajiras are strong, progressive, and aggressive; the Arhuacos are weak, inveterate coca chewers, sedentary, and shun contact with the outside world. They have a curiously Asiatic look; indeed, they were formerly referred to by the Colombians as "Chinos" rather than as "Indios." Among the Arhuacos families

[8] J. Alden Mason: Coast and Crest in Colombia: An Example of Contrast in American Indian Culture, *Nat. Hist.*, Vol. 26, 1926, pp. 31–43.

are small, with two children as the usual maximum. Intermarriage with Colombians, either white or black, is rare, nor do the Arhuacos mingle with the adjoining Goajira tribes. The name "Arhuaco" is not used by the Indians themselves; it, or rather the original form of it, "Aurohuacos," seems to have first appeared in José Nicolas de la Rosa's "Floresta de la Santa Iglesia Catedral de la Ciudad de Santa Marta" (1739). Its similarity in sound to Arawak, one of the large primitive stocks of South American Indians, suggests a possible origin of the name, though anthropologically it is misleading. The tribe is not identified with the ancient inhabitants of the

FIG. 7—San Miguel. The square houses include the Catholic church, bishop's house, and house for guests. (Drawn from a photograph by E. W. Emmart.)

Sierra Nevada. These were the Taironas, a warlike people as compared with the peaceful Arhuacos. The Taironas disappeared four hundred years ago, and the Arhuacos will probably not long survive. There are probably not more than 3000 Arhuacos all told in the Sierra Nevada. That branch of the Arhuacos living on the northern side of the mountains is known as Kagaba (or Köggaba). Those on the southern side are the Ijca (De Bréttes refers to them as the Bintoukouas). There are also smaller groups—the Sanha, Busintana, Gouamakas, and Marocaso.

Above San Miguel are several small settlements of three or four huts each where priests reside. The *cansamarias* are here at their best (Fig. 5). The priests also represent the finest specimens of the dying Arhuaco race. Two of these groups of huts are named—the first, Taquina, where lesser priests reside; and the second, Macotama, the home of the most renowned priest, or *mama*, in these parts, patriarch of the Arhuacos, famed far and wide for his medicinal powers. He was not at home on our upward journey, but on the return we met him (Fig. 4), and in the customary exchange of gifts I received a kerchief full of camomile, a plant cultivated in abundance around the huts of the priests and used medicinally.

The tree line is passed shortly after leaving San Miguel, at about 6000 feet. On Mt. San Lorenzo, on the western side of the Sierra Nevada, at this altitude and higher—up to 7500 feet—there occurs the tall wax palm *Ceroxylon* (Fig. 8). *Nectandra*, which the natives know as laurel, climbs highest of the dicotyledonous trees. Four hours of hard going from San Miguel bring one to a group of mud huts at an altitude of 9200 feet. Fog and the usual afternoon rain make further climbing inadvisable. Again there is a pronounced change in plant life. Only shrubs, grasses, and alpine herbaceous forms now cover the few areas where there is soil.

THE PÁRAMOS

Another half day brings one to the last group of shepherds' huts, at 12,600 feet. We are here at the edge of the páramo, which in this region is mostly bare rock

FIG. 8

FIG. 9

FIG. 10

FIG. 8—The wax palm at 7500 feet on Mt. San Lorenzo.
FIG. 9—Laurel trees forming the tree line at 7000 feet on Mt. San Lorenzo.
FIG. 10—The páramos at 12,600 feet.

(Fig. 10). At 14,000 feet the glacial Lake Macotama is reached, and 1200 feet higher a second smaller body of water, named Summit Lake by Carriker. Neither lake contains any fish. Just above the second lake on the floor of the páramo, at an altitude of 16,000 feet, a distinctive alpine vegetation flourishes. Among the flowers the elegant purple spike of the lupine is conspicuous, and the semi-arborescent frailejon (*Espeletia*), a plant like a gigantic mullein in appearance and limited to the páramos. Carriker states that the flowers of frailejon furnish a large portion of the food of humming birds, which are very numerous in the Sierra Nevada. The queen of all the alpine flowers is *Draba*, and it has the added honor of climbing the highest. A specimen was collected on the crest of the ridge, protected in the crevice of a rock, at an altitude of 17,640 feet. It proved to be a new species and has been named *Draba sanctae-martae*. Of the 600 plants gathered some thirty were heretofore unknown to science; they include among them new species of *Weinmannia*, *Piper*, *Peperomia*, and *Tibouchina*. The altitude of 17,640 feet is probably a record for flowering plant life in the Sierra Nevada de Santa Marta. Ferns persist on the páramos, chief among them the indigenous and extraordinary *Jamesonia*, its narrow, stiff frond, 18 inches tall, resembling a flattened stick stuck in the ground. The only animal seen at this altitude was a small, glistening, ebony-black frog (*Antelopus carrikeri*).

The weather on the morning of our arrival at the last camp (12,600 feet) was not propitious; heavy fog had collected, and a cold wind, threatening snow, whistled across the páramos. Only two of our party continued beyond 16,500 feet. Over bare rock and through patches of snow we slowly climbed upwards, finally reaching the ridge which is the crest at that point. Over the edge is a sheer drop of some two or three thousand feet to the valley below. A sudden rift in the clouds revealed the peaks to the west, at least two thousand feet higher. The ridge increased in elevation to the east. We proceeded in this direction, climbing slightly higher, until we came against a rocky prominence that defied ascent. The setting in of a driving snowstorm was the final circumstance that turned us back.

The Height of the Sierra Nevada

Statements in regard to the maximum height of the Sierra Nevada de Santa Marta range between 18,000 and 21,000 feet. Only De Brettes has ascended the highest peaks, and he gives 5887 meters (19,310 feet) as the altitude of the summit. The crest of the ridge reached by us is 17,640 feet. The snowy peak just beyond, to the west, rises at least 1500, if not 2000, feet above. This peak is therefore certainly not less than 19,000 feet. Wollaston's photographs show the snowfield and indicate it to be of substantial size. The central peaks of the range are still higher and rise enough above the others to dominate them when viewed at a distance. They too show snowfields. A conservative estimate of the altitude of the Sierra Nevada de Santa Marta places it at 20,000 feet.

AMERICAN GEOGRAPHICAL SOCIETY

The March Meeting. The regular monthly meeting of the American Geographical Society was held on March 20, 1934, at the Engineering Societies' Building, 29 West 39th Street, Mr. Oliver B. James in the chair. Dr. Frank R. Oastler delivered a lecture entitled "The Lake Regions of the Canadian Rocky Mountains." For the past twenty-five years Dr. Oastler has been photographing in the western mountain ranges of North America from Alaska to Mexico, and he enjoys a well merited reputation for the beauty of the results he has achieved. The colored lantern slides shown at the lecture were mainly obtained on a trip in the summer of 1933.

The April Meeting. The regular monthly meeting of the Society was held on April 24, 1934, at the Engineering Societies' Building, 29 West 39th Street, Mr. Oliver B. James in the chair. Miss Louise A. Boyd addressed the Society on her "Expedition to East Greenland in 1933." In introducing Miss Boyd Mr. James spoke of her contributions to the advancement of geographical work in the Arctic and the recognition they have received. Miss Boyd's lecture dealt mainly with the results of her latest expedition. A short report on it appears in this number of the *Review;* the complete account will be published in book form by the Society.

Elections of Fellows. At the March and April meetings of the Society there were presented with the approval of the Council the names of 43 candidates who were duly elected as Fellows of the Society.

Honor to Otto J. Schmidt and George A. Ushakov. A dinner in honor of the Soviet explorers Otto J. Schmidt and George A. Ushakov was given on May 23 by the American Russian Institute for Cultural Relations with the Soviet Union and the Explorers Club, the American Museum of Natural History, and the American Geographical Society. Professor Schmidt, chief of the State Administration of the Northern Sea Route, which directs and coördinates all Soviet Arctic activities, was in command of the *Chelyuskin* on the attempt to repeat the success of the *Sibiriakov* in 1932 and make the Northeast Passage in a single season. When only six miles from Bering Strait the ship was beset, October 16, 1933. She was carried northwestward in the pack and finally sank February 13, 1934. Plans for rescue by airplane were immediately put under way, and under Ushakov's leadership the 101 survivors (only one man was lost) were flown safely from the ice floe to land, the task being completed by April 12. A graphic account of the voyage of the *Chelyuskin* and the gallant work of rescue was given by Professor Schmidt at the dinner. Other speakers were the Soviet ambassador, Alexander A. Troyanovsky, Roy Chapman Andrews, Vilhjalmur Stefansson, and Sir Hubert Wilkins. The American Geographical Society was represented by Vice-President Philip W. Henry and W. L. G. Joerg, in charge of the Society's studies on the Polar Regions.

The Millionth Map of Hispanic America. Six new sheets of the Map of Hispanic America on the scale of 1 : 1,000,000 have now been published, making a total of 50 published sheets. Of the remaining 52 sheets of the map, 24 are fairdrawn and ready for lithographing and printing and 15 others are compiled and ready for fairdrawing. This leaves a total of 28 sheets to be drawn and 11 to be compiled.

The new sheets include one sheet in Mexico, North H-13 (Chihuahua); one in Colombia, North C-18 (Barranquilla); three in Brazil, South B-21 (Río Tapajóz), South B-23 (Therezina), and South C-23 (Río São Francisco); and one sheet in the Argentine Republic, South J-20 (Bahía Blanca).

GEOGRAPHICAL RECORD

NORTH AMERICA

Newfoundland and Her Fisheries. Since the discovery in 1497 the fortunes of Newfoundland have rested on her fisheries. How close is the dependence is made clear in the report of the Newfoundland Royal Commission of 1933, on whose recommendation Newfoundland has temporarily reverted from dominion to crown-colony status. Today one-quarter of the population are engaged exclusively in the catching and curing of fish; another one-eighth are fishermen-farmers. Fishery exports, which amounted to more than 16 million dollars in the year 1928–1929, declined to less than 6½ million in 1931–1932. During the latter year the value of newsprint and mineral exports was nearly 15½ and 3½ million respectively, but these industries yield comparatively little local benefit. The two paper mills at Grand Falls and Corner Brook employ some 1400 men and 3000 in the woods during the cutting season when working full time; the Wabana iron mine, 2200 men during normal time, now greatly reduced; the lead-zinc mine at Buchans, 350 men (on the forest and mineral resources of Newfoundland see Julian E. Rothery: The Newest Map of the Oldest British Colony: A Map of Newfoundland, 1932, *Geogr. Rev.*, Vol. 23, 1933, pp. 564–577).

In the winter of 1932–1933 one-fourth the population was in receipt of relief. The world-wide depression has, of course, contributed to the present state. Note, for instance, the effect of the coffee crisis in Brazil: "Brazil is the largest consumer of salt cod in the world, and may be regarded as the key to the world market situation. Her inability to purchase in large quantities since 1929 has led to the flooding of other markets with excessive supplies, and has contributed to the lowering of the world price level for salt fish" (R. F. Grant: The Canadian Atlantic Fishery, Toronto, 1934, p. 50). But the Commission points out that "recurring visitations of pauperism necessitating large payments for relief have always been a feature of the Island's economic history and must continue to be so, while the fishery is conducted on its present basis and remains the mainstay of the country" (Newfoundland Royal Commission 1933, Report, *Cmd. 4480*, London, 1933, p. 50).

The present distribution of population reflects the ancient dominance of the fisheries. Apart from the 40,000 people in St. Johns, the remainder of the island's 282,000 inhabitants are scattered among 1300 settlements along the 6000 miles of coast. The very name "outports" suggests the difficulties and expense of administering these isolated communities. A number of outports, especially on the northern peninsula, cut off from communication for six months of the year, and on the south coast, which though ice-free is rocky and barren, "are situated in places which, judged by modern standards, would not be regarded as suited to human habitation." Historical causes are mainly responsible for the location of three-quarters of the population on the east coast. The harbors of the Avalon Peninsula were the early resorts of fishing vessels and were the first to be settled when the ban on colonization was lifted. It must be remembered that before the second decade of the nineteenth century to build a house or reside in Newfoundland was illegal—an edict that had unfortunate effects on the agricultural development of the island (cf. J. L. Paton: Newfoundland: Present and Future, *International Affairs*, Vol. 13, 1934, pp. 394–409). As William Knox wrote in 1793, "The island of Newfoundland had been considered in all former times, as a great English ship moored near the Banks during the fishing season for the convenience of English fishermen" (quoted by H. A. Innis in his editorial preface to Grant, *op. cit.*). Others, however, also sought the conveniences of the island. The French rights on the west coast granted by the Treaty of Utrecht and not abrogated until 1904 held back colonization from some of the best parts of the island.

Until the mid-nineteenth century the fisheries were under a feudal organization, a sort of truck system, which developed into the present credit system, whose evils have long been recognized. Among other features in a "catalogue of misfortunes" the Royal Commission points to the loss of first place in the world's markets for heavy-salted fish and the virtual impoverishment of the Labrador fishery; a severe decline in the Bank fishery; a deterioration in the cure in the shore fishery as well as in the Bank and Labrador fisheries; depletion of vessels and gear and deterioration of equipment; absence of organization or coöperative effort; and lack of suitable local shipping for carrying fish to market, for which purpose the chartering of Scandinavian vessels is the almost universal practice. Norway and Iceland have also become Newfoundland's serious competitors in the world salt-fish markets. The progress made by the latter is particularly remarkable. In 1885 Iceland's exports of fish amounted to 100,000 quintals against 1,300,000 for Newfoundland; in 1932 the respective figures were 1,500,000 and 1,050,000. Some interesting details are given by Mrs. Grant. For instance, the imports of salt codfish in the Oporto market in 1927 were 700 tons from Iceland and the Faroes against 18,720 tons from Newfoundland and Canada; while in 1931 the respective figures were 8875 and 8525 tons (*op. cit.*, p. 58).

Physiography of Northern Labrador. As geologist of the Grenfell-Forbes Northern Labrador Expedition of 1931 (see Alexander Forbes: Surveying in Northern Labrador, *Geogr. Rev.*, Vol. 22, 1932, pp. 30–60) N. E. Odell made a number of physiographic observations (The Mountains of Northern Labrador, *Geogr. Journ.*, Vol. 82, 1933, pp. 193–210 and 315–325). Northern Labrador is underlain by metamorphic rocks, all probably of pre-Cambrian age. The strata were folded into mountains, which were peneplained in post-Cambrian time. Later the coastal region was uplifted. As the land rose, the rivers cut down their beds, and they now flow through the mountains from a watershed located far to the west of the highest summits. Still later the region underwent a considerable depression, as the drowned coast line testifies. During the last glacial epoch the land was weighed down by the ice and has subsequently risen, the highest beaches descending from 250 feet at Nachvak to sea level at Ikordlearsuk, some twenty miles south of the northernmost point on the mainland.

While A. P. Coleman contends that the high tablelands and the mountain summits of northern Labrador were ice-free during the last glacial epoch, the ice in this region not reaching higher than about 2000 feet above the sea, Odell concludes that the last Labrador ice sheet completely inundated the Torngat and Kaumajet ranges and reached the sea. The difference of opinion essentially centers about the rate of the frost action. From his observations in Spitsbergen Odell holds that the frost phenomena in the Labrador mountains could have been produced in post-Wisconsin time—a view that will be shared by all who have studied the activity of the frost in the polar regions. The conclusion regarding the great thickness of the last ice sheet is also based on the occurrence of ice-polished ledges at high elevations; for instance, at 4700 feet in the Central Range of the Torngats and at 3600 feet on one of the highest summits in the Kaumajet Mountains. However, more detailed fieldwork may be needed before we are justified in concluding, as does Odell, that *all* land was ice covered and that no plants survived the last glaciation in this region.

Movements of débris by frost and their results such as solifluction, stone gatherings, and stone nets are in evidence everywhere in the Labrador mountains.

ERNST ANTEVS

Nivation Depressions and Other Alpine Land Forms in the Western United States. In areas of our western mountains above the cold timber line the slow rate of evaporation compensates for the low precipitation, so that, as far as erosion is concerned,

the climate is humid. The principal factor in erosion is frost action induced by the numerous fluctuations of air temperature across the frost line. These are estimated by Russell to occur on at least a third of the days of the year (R. J. Russell: Alpine Land Forms of Western United States, *Bull. Geol. Soc. of America*, Vol. 44, 1933, pp. 927–949). In a climate of this truly alpine type the principal factors in erosion outside areas covered by glacial ice are the processes of nivation, solifluction, and altiplanation.

Reviewing the work of Matthes, Andersson, and Eakin, the author stresses the importance of these processes not only in Recent and Postglacial time but also during the fluctuations of climate of the Pleistocene. He believes that, because glacial cirques and glacially scoured U-shaped valleys are easily distinguishable on maps, too much emphasis has been laid on these features. Nivation cirques (niches of Hobbs), solifluction slopes, and altiplanation terraces, although individually smaller, should have their combined impress on the topography recognized. One must sympathize with this view, but it is natural that the major features should receive first attention. We are, however, passing into a period when more detailed work on land forms is necessary in order to define the conditions of their origin more precisely. Thus, Russell's attempt to correlate the form of nivation cirques with the permanence of the snow bank is in line with progress. The work of frost and related processes under alpine, arctic, and periglacial conditions is now widely recognized in Europe, where notable results have been achieved along several lines of attack. It is a hopeful sign that work in this field is urged by so persuasive an advocate.

KIRK BRYAN

Present Land Utilization in the State of Washington. The state of Washington at present is characterized by diverse agricultural land utilization, ranging from small irrigated orchards to huge dry-farming wheat ranches. Four major types of land uses constitute the areal pattern (R. E. Willard and N. W. Johnson: Present Land Uses—Washington; Types of Farming Series, Part 1, *State College of Washington Agric. Exper. Sta. Bull. No. 288*, Pullman, 1933). Irrigated farming occupies 4.5 per cent of the area; nonirrigated farming, 27 per cent; national forests and alienated lands within their boundaries, 26 per cent; and all other lands—composed chiefly of cut-over and privately owned timberlands west of the Cascades and of submarginal wheat lands, used only in periods of high wheat prices, east of these mountains—42.5 per cent. The map of "Major Land Uses—Washington," scale 1 : 500,000, adds detail to the regions of that state as given on the Bureau of Agricultural Economics and the Bureau of the Census maps "Natural Land-Use Areas of the United States" and "Type of Farming Areas in the United States: 1930" respectively (noted in *Geogr. Rev.*, April, 1934).

Less than 32 per cent of the total area of the state is in farms both irrigated and nonirrigated (figures are from the 1930 census). The Cascade Mountains are a distinct division between types of agricultural land utilization. East of the Cascades 80 per cent of the area is in farms: a high proportion of this is in crops, particularly in the wheat lands of the southeast. West of the mountains less than 20 per cent of the area is occupied by farms: a large part of this is in pasture. These are small farms devoted to dairying, poultry raising, fruits, and truck crops. The eastern farms are large, averaging 350 acres, and, even though only 47 per cent of the farms of the state are there, they include 86 per cent of the farm area. West of the range the farm average is 51 acres, with the greatest farm concentration in the irrigated fruit lands. The pattern of Washington's major land uses is laid upon a physical landscape in which the conspicuous elements are a low interior plateau with a steppe climate and an alkaline soil separated by a mountain range from a coastal lowland possessing a marine climate and leached soil.

JOHN H. GARLAND

EUROPE

The Upper Silesian Boundary. "The most disputed plebiscite ever held" is Sarah Wambaugh's characterization of the plebiscite that determined the present political boundary of Upper Silesia (Plebiscites Since the World War, 2 vols., Washington, 1933). To draw a line, on the basis of the plebiscite, that would be conformable "to the wishes of the inhabitants" was impossible without the creation of numerous enclaves, for the voting in the industrial area was a veritable mosaic. As it is "the boundary twists and turns, dividing here a chateau from its stables, there a village from its cemetery; reaching the industrial area, it separates factories from their electric power, miners from their mines. Even shafts of the same mine are in different countries. Foundries of the Polish part are dependent on coke from the German part; the industries of the German side, on the raw materials from the Polish area" (Vol. 1, p. 269).

Richard Hartshorne has taken this most difficult case of Upper Silesia for the subject of an essay on the geography of political boundaries with the object of suggesting "a method and some terminology that might be applicable for any border study" (Geographic and Political Boundaries in Upper Silesia, *Annals Assn. of Amer. Geogrs.*, Vol. 23, 1933, pp. 195–228). Such studies are earnestly to be desired and Professor Hartshorne is to be congratulated on his effort. His article "The Upper Silesian Industrial District" in this number of the *Geographical Review* (pp. 423–438) shows the complexity of the problem before the boundary makers. Attention is especially called to the accompanying maps. Other striking maps appear in the paper in the *Annals:* among them we may note those (Figs. 8 and 11) showing the way in which highway and railroad communications are cut by the old and new boundaries. The former Polish frontier ("antecedent" boundary), "one of the oldest boundaries in Europe, is still one of the strongest divides on the map. Fewer roads and railroads cross it than almost any other divide in this part of Europe, outside of the high mountains." The new "subsequent" boundary in the industrial district "crosses surely more lines of transportation than any other equal stretch of international boundary in the world."

An important point noted is the change in sentiment and in shift of population on either side of the present boundary since its creation. "The study of the minority movement of each side indicates, I think, that no district including both town and country on either side of the line could now show a majority vote for the foreign nationality. In other words, the new political boundary has perhaps forced the nationality boundary to conform to it." And Miss Wambaugh concludes that "the mass of the German and Polish inhabitants of both sides, if let alone, would not be preoccupied with any change of sovereignty. Should the area again become an international problem it is unlikely that it will be owing primarily to the people of the territory but rather to the larger concerns of European politics."

Professor Hartshorne's treatment of the subject raises one query. The assumption is, he says, "that where international boundaries run through settled areas, it is those areas rather than the bounding states that are most concerned, the inhabitants of the border regions rather than those in the internal areas of the states who are most to be considered in studying or locating boundaries." But can the issue between the nations as a whole be ignored in the local frontier study?

Modern Transportation in the Netherlands. The status of transportation in the Netherlands and the developments during the past century are discussed at length in a series of papers published on the occasion of the sixtieth anniversary of the Royal Netherlands Geographical Society (Het verkeer in Nederland in de XXe eeuw, *Tijdschr. Kon. Nederl. Aardrijksk. Genoot.*, Ser. 2, Vol. 50, 1933, pp. 331–662). The waterways have still retained a large importance, not only on account of the

physical environment but because of a farseeing government policy that tried to maintain a proper competitive balance between rail and water transportation by constantly improving the network of natural waterways and canals.

Among recent improvements the deepening of the main entrances to Holland from overseas and the expansion of the principal ports may be mentioned first. Since 1920 the depth of the Nieuwe Waterweg-Nieuwe Maas, the entrance to the port of Rotterdam, has been increased to 30 feet below low-water mark, or 34½ feet below high tide. Further deepening of the channel to 37½ feet below high-water level is contemplated. The port of Rotterdam is growing constantly; a number of new basins have been dug to the west of the older ones, while still others are in the course of construction. The entire area on both sides of the Nieuwe Maas and the upper Nieuwe Waterweg has become one great commercial and industrial region, which includes such smaller ports as Schiedam, Vlaardingen, and Maassluis.

The entrance to the port of Amsterdam—the North Sea canal—has also been greatly improved. The depth of the canal is being increased to 36 feet, while at the western end a third lock has been built, at present the largest in the world—1200 by 150 by 45 feet. Although the tonnage moving through the North Sea canal remains considerably below that passing the Hoek van Holland, the port of Amsterdam is of vital importance in the economic life of the Netherlands. Where Rotterdam is primarily a port of transit, handling large quantities of bulk goods of relatively low value, Amsterdam has succeeded in maintaining its old colonial trade and ships more piece goods of high value. This essential difference has made itself felt in the equipment of the two ports. In Rotterdam wharves are not necessary for the transshipment of many goods, and floating equipment can be used, while in Amsterdam a considerable length of wharves must be available. In recent years Amsterdam has been growing westward along the North Sea canal. Also, here there tends to develop, though on a somewhat smaller scale, a commercial-industrial complex similar to that near Rotterdam along the Nieuwe Maas and neighboring waters. The deepening of the Oude Maas will also provide a new and better entrance for the port of Dordrecht and will thus aid in relieving congestion on the Nieuwe Maas.

The principal delta branch of the Rhine and the main artery of river traffic in the Netherlands is the Waal. A depth of 9 feet below the Cologne low-water mark is kept in the river by narrowing it to a standard width of 780 feet at average low water. From the Waal river traffic passes through the Boven Merwede, Beneden Merwede, and the Noord to Rotterdam; traffic destined for Antwerp passes from Dordrecht southward through to Dordtsche Kil. All these waterways have been improved.

The middle delta branch of the Rhine, the so-called Beneden Rijn-Lek, carries only about one-third as much water as the Waal. Its depth is maintained at six feet, and only during periods of relatively high water is it used to any great extent by Rhine vessels. Plans are in the course of execution to increase the depth to 9 feet.

The so-called Merwede canal, connecting Amsterdam with the Rhine, has long been unsatisfactory because of crowded conditions and insufficient width and because its locks accommodate vessels of not more than 2000 tons. A new canal is under construction, which will follow the existing canal as far as Utrecht and from there reach the Waal above Tiel. Its depth will be 12 feet below the lowest water level, its width—120 to 150 feet—more than twice that of the existing canal, while over the entire distance of 47 miles only two locks will have to be passed.

The great development of coal mining in South Limburg has created the need for better transportation facilities for this part of the country. Good railroad connections with the north existed, but water transportation is more economical for such a low-grade bulk product as coal. With this in view the Maas and the Waal were connected by a canal, completed in 1927. The Maas itself has in recent years been canalized from Maasbracht to Grave. This involved the building of five barrages, each provided with a set of locks. A depth of 9 feet will be maintained. A new

canal, the Juliana canal, from Maasbracht southward to Maastricht is under construction. The entire complex will be able to accommodate ships of up to 2000 tons. The construction of the Juliana canal offers some unusual difficulties: over considerable distances the water level will be above the neighboring territory.

Another complex of canals is under construction to connect the industrial district of Twente with the Rhine and thus with the coal basins to the south in Holland and Germany. These canals will be accessible to ships of up to 1350 tons. Construction started in 1930, and the first unit is expected to be completed by 1936.

The motorization of road traffic, which progressed rapidly after the war, created a difficult problem. Holland possessed quite a large number of paved (mostly brick) main roads, but these had generally been designed for local purposes, and few of them were adaptable as through routes. In recent years the government has energetically proceeded to improve this antiquated road system. Proceeds from a road tax on all automotive vehicles and certain other money served to establish a road fund. A road plan for the entire country was drawn up and also plans for the different provinces, all to be periodically revised. On the national road plan are indicated the roads for through traffic. The 1932 plan makes provision for more than 2000 miles of through roads, many of them entirely new ones, which avoid as far as possible all important settlements. In a country crisscrossed by so many streams and canals the road plans had to be accompanied by an extensive program of bridge building. The connections with the south especially leave much to be desired. Three large new bridges have recently been completed in the central part of the country, four others are under construction, while plans have been provisionally approved for six more. The new bridge across the Waal River at Zaltbommel may serve as an example of these structures: this bridge, without the approaches, has a length of 2600 feet and lies 51 feet above lowest water level. When these bridges are completed, four major routes between north and south will be available.

In the Netherlands, as elsewhere, railroad traffic has found a dangerous competitor in the automobile. The number of private automobiles (about 75,000 in 1931) is probably not sufficiently great seriously to affect passenger transportation, but trucks (about 50,000) and busses (about 4000) take considerable freight and an increasing number of passengers from the railroads. According to an unofficial estimate, which may be slightly too high, trucks transported in the year 1930 about 13 million tons against 26½ million carried by the railroads. Since competition with bus and truck transportation has especially affected the short hauls, the railroads are inclined to give more attention to fast through traffic.

WILLIAM VAN ROYEN

New Administrative Subdivision of the Ukraine. The Ukrainian Soviet Socialist Republic is one of the seven allied republics composing the Union of Soviet Socialist Republics and covers an area of 452,000 square kilometers, with a population of 31,403,200 (as of January 1, 1931). By nationalities, 80 per cent of the population is Ukrainian; 9.5 per cent, Russian and White Russian; and more than 5 per cent, Jewish.

In 1925 the old division of governments (eight provinces and part of another) was abolished and the territory divided into 40 districts (okrug), subdivided into 625 regions (rayon), partitioned in turn into 10,733 communes (selsoviet). The Moldavian Autonomous Soviet Socialist Republic was established along the western boundary of the Ukraine in 1924.

In 1930 another administrative scheme of subdivision was put into effect. The districts were abolished throughout the U.S.S.R., and the Ukraine was divided directly into 374 regions and 21 independent towns, which in all included 11,038 communes.

In 1932 the system was again discarded as impractical and the Ukraine divided into 7 territories (oblast), subdivided into 374 regions and 21 independent towns.

The new administrative subdivisions with their capitals are shown on the map, Figure 1. This new scheme closely resembles the prerevolutionary system of division into governments.

Among the units making up the Ukraine, the Moldavian Autonomous Soviet Socialist Republic possesses singular characteristics in a political sense. Situated along the Dnestr River—the frontier line vis-à-vis Bessarabia, the province annexed by Rumania—it covers an area of 8481 square kilometers, with a population of 578,822 (as of January 1, 1931). Divided into its component nationalities, the population is as follows: Moldavian, 30.1 per cent; Ukrainian, 48.5; Russian, 8.5; Jewish, 8.5. The international boundary line of the U.S.S.R. on the official Soviet map includes Bessarabia as an integral part of the Ukraine, a broken line designating the boundary between Rumania proper and the U.S.S.R. (the accepted system for all official maps of the U.S.S.R.). The name "Moldavian" given to this tiny republic with only three-tenths of its population Moldavian, together with the significant design of boundary lines, demonstrates quite clearly that the idea of retrieving Bessarabia has not been given up by the U.S.S.R.

FIG. 1—New administrative divisions of the Ukraine.

N. KRIJANOVSKY

ASIA

The Census of Palestine, 1931. On November 18, 1931, a count was taken of the people of Palestine from Dan to Beersheba. Of the 1,035,821 persons enumerated 47,981 were "true nomads" of Beersheba. This large district, occupying nearly half the total area of Palestine, has only 4 persons to the square kilometer, mainly nomadic. Its population is probably either stationary in numbers or increasing at a very low rate. The estimate of 71,108 for 1922 must have been much too great; and the more credit goes to the effort by which an actual count was made in 1931 by a specially devised primitive form of enumeration. Beersheba apart, Palestine shows an extraordinary increase in population—37 per cent—for the nine-year period 1922–1931. Distribution of increase by racial elements is very uneven: 28.6 per cent for Moslems, 108.4 per cent for Jews. Of the Jews in Palestine 58 per cent were foreign-born. The Jewish element now amounts to 17 per cent of the total population. The territorial distribution of increase is also uneven. Of the natural divisions, the Maritime Plain shows the greatest increase, the density of population rising from 52 to 78 a square kilometer: the subdistrict of Jaffa alone increased from 195 to 434 a square kilometer. Town population has gained over rural. The proportion of Jews to Moslems in the towns is 3 to 1. Sixty per cent of the town population is in the four towns of Jerusalem, with 90,500, Haifa, Jaffa, and Tel Aviv, each with about 50,000. These towns, furthermore, are the only ones showing any likeness to the urban communities of western civilization, and even they are in too immature

a state of economic development to predict their future. "Jaffa and Tel Aviv both have a sense of security in the development of agriculture, particularly that part of it concerned with the cultivation of oranges and grape-fruit, but Tel Aviv does not bear in its age, sex, and conjugal constitutions the marks of a progressive commercial or industrial development like that of Haifa or Jaffa. The development of Haifa and its port works may have a considerable effect on both Jaffa and Tel Aviv." Jerusalem, the "supranatural," "has no very well defined features assisting towards an estimate of its future. In the material sense, it will probably remain a residential centre for the professional classes and, through them, will provide a general but limited market for the natural produce of the country."

The nature of the movement of the population of Palestine as exhibited by the 1922 and 1931 censuses and discussed by Mr. E. Mills in Volume I of the Report of the 1931 Census (explanation and subsidiary tables) is provocative of thought. Palestine is a buying country, its imports being about eight times the value of its exports, and thus it has been comparatively favored in the economic crisis; but when world prices are adjusted between supply and demand "the problem in Palestine will be to meet the demand for subsistence by proportionate increases in export trade, and in the Christian and Jewish invisible contributions of value upon which the whole population relies, perhaps unconsciously."

The Climates of Japan. A recent paper by M. Isozaki, "Thornthwaite's New Classification of Climate and Its Application to the Climate of Japan" (*Journ. of Geogr.*, Tokyo Geographical Society, Vol. 45, 1933, pp. 234–245; in Japanese), calls for comment. It attempts to apply to Japan the classification that I developed for North America (*Geogr. Rev.*, Vol. 21, 1931, pp. 633–655) and later extended over the earth (*Geogr. Rev.*, Vol. 23, 1933, pp. 433–440). However, Isozaki assumed that the formula for determining precipitation effectiveness, $P/E = 11.5\,[P/(T-10)]^{\frac{10}{9}}$, generalized from evaporation data collected in the continental United States, might be transformed and used for the determination of particular evaporation values. Obviously this could not be done successfully. The ratio P/E, when determined from the use of the formula, should be thought of as an index of precipitation effectiveness and not as the quotient of actual precipitation and evaporation values.

Isozaki states that he tried the formula on two or three stations and found the computed evaporation values to be different from those observed, so he determined not to use it. He decided to use the actual evaporation data tabulated in Okada's "The Climate of Japan" (*Bull. Central Meteorol. Observatory of Japan*, Vol. 4, 1931, pp. 89–416) in connection with the precipitation data and to make direct determinations of P/E. He does not state precisely how he made the determinations, and I have been unable to obtain the same indices by any manipulation of the data.

He has published in his paper a table giving the P−E index and classification of 99 stations; the indices are from 50 per cent to more than 100 per cent higher than those I obtained from the use of the formula. At the same time they are only about half as great as those I obtained from the use of precipitation and evaporation data. His map, although employing my symbols, is really not at all a map of climate according to my classification, and his conclusions concerning the merits of my classification in connection with the climate of Japan accordingly have no meaning.

I have used the P−E formula in making computations for 114 stations and have prepared another map of the climates of Japan. This is shown in Figure 1, and, needless to say, this is the one to be used in any test of the validity of my method as applied to Japan.

A comparison of the two maps will disclose great differences in climatic distribution. On Isozaki's map 80 out of 99 stations are represented as having "A" (rainforest) climate, whereas I found only 30 out of 114 stations to fall into that category when determined by the use of the P−E formula. Isozaki represents the four principal

islands as being practically all AB′r and AC′r, whereas I find only the southern coasts and the coast facing the Japan Sea to be AB′r and AC′r; most of the area is "B." Isozaki maps most of Formosa as AA′r and AB′r, but I find only BB′r, BB′w, and BA′w (five stations). Likewise the climatic pattern in Korea and Manchuria is very different on the two maps.

On the other hand, in Fukui's map of the "Climatic Provinces of Japan" (*Geogr. Rev. of Japan*, Vol. 9, No. 1–4, 1933; in Japanese, with brief abstract in English) the pattern of climates is closely similar to mine. Since Fukui's climatic divisions are descriptive, they can be related to the climates of other parts of the earth only through the medium of some quantitative world classification or by the comparative study of vegetation distribution. These two classifications seem to supplement each other in a satisfactory manner.

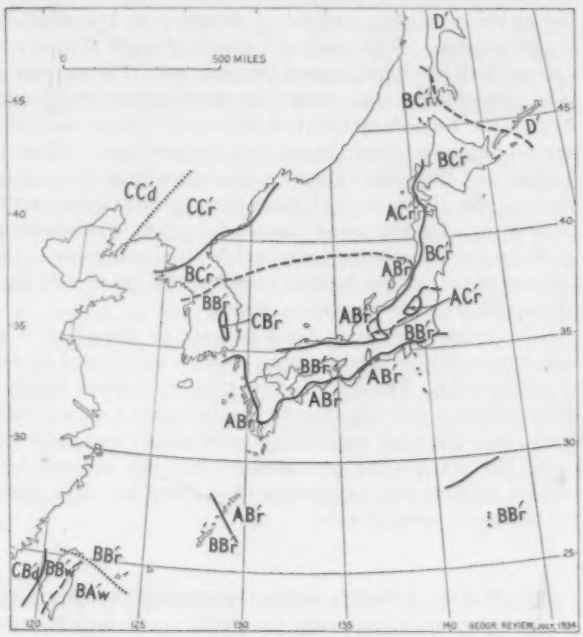

FIG. 1—The climates of Japan.

I have been puzzled to find that many students have failed to see that my formula for evaluating the effectiveness of precipitation is no different in principle from those of Lang, De Martonne, and Köppen. The Lang formula, $I = P/T$, indicates that the effectiveness varies directly with precipitation and inversely with temperature. De Martonne's formula, $I = P/(T + 10)$, is a slight refinement of Lang's. Köppen's three formulae, for 1918, 1923, and 1928 respectively, $I = 8P/(5T + 120)$, $I = 2P/(T + 33)$, and $I = P/(T + 7)$, where an index number of 1 separates desert and steppe and an index of 2 is the humid border of steppe, are, like Lang's and De Martonne's, trial-and-error attempts to evaluate the effectiveness of annual precipitation in terms of the mean annual temperature. Except for the existence of various seasonal régimes of precipitation, it would be a very simple matter to determine mathematically the exact relations between precipitation and temperature along the various climatic boundaries, and there should be no need for fitting and adjusting as in the five formulae listed above. But the occurrence of rain prevailingly in summer in some places, prevailingly in winter in some, and well distributed throughout the year in others makes it undesirable to express climatic boundaries in terms of relations between mean annual temperature and total annual rainfall. Köppen's attempt to consider seasonal concentration of precipitation by the use of two additional formulae is lacking in precision and mathematical finesse, as Russell has pointed out (Dry Climates of the United States: I, Climatic Map, *Univ. of California Publs. in Geogr.*, Vol. 5, No. 1, Berkeley, 1931, pp. 1–41). The rainfall of each month must be evaluated in terms of the temperature of the month

if one is to devise a single formula that will recognize seasonal régimes of precipitation.

Monthly values of precipitation and temperature have no visible expression in the landscape through control of vegetation, soil, and land forms, since these phenomena are expressions of annual or seasonal climatic averages. Thus relations between monthly values of precipitation and temperature cannot be tested by direct comparison with distributions of any of these phenomena. Since monthly ratios are not immediately susceptible to empirical treatment, it becomes necessary to devise some rational method of determining the effectiveness of monthly values of precipitation. This method I sought through the use of evaporation data in connection with precipitation and temperature. The formula, $I = 11.5\ [P / (T-10)]^{\frac{10}{9}}$ is of precisely the same nature as those enumerated above, except that it employs data in the English rather than the metric system and utilizes monthly rather than annual values of precipitation and temperature. All of these formulae yield P–E indices, and the index values limiting climatic areas must be determined empirically through the observation of extra-climatic phenomena such as vegetation, soil, and land forms. De Martonne's humid boundary of the desert is his P–E index value of 5, Köppen's limit is the index value of 1, and mine is the index value of 16. A critique of the various formulae need be concerned only with the fit in the landscape of the climatic lines thus determined.

Since evaporation data for Japan are so abundant, it would seem that Isozaki was thoroughly justified in using them in attempting to determine the effectiveness of precipitation. The P– E indices that he obtained should give satisfactory climatic differentiation, but the climatic limits would certainly have different index values from mine, and they would have to be determined empirically. This might well be done, but the method and results could not be used for comparison with other regions because the meagerness of evaporation data elsewhere would not permit the necessary computations.

C. W. THORNTHWAITE

Chiri-Ronso: A New Japanese Geographical Bulletin. The Geographical Institute of Kyoto Imperial University has commenced the publication of a new geographical magazine, *Chiri-Ronso* (*Geographical Bulletin*). Its numbers are to appear once or twice a year without set dates of issue. The opening number (1932) contains ten papers and a number of geographical notes. Among the papers are two studies in regional geography, two in historical geography, two in economic geography, three in the geography of settlement, and one on the philosophy of geography. All the papers have merit, and three are of unusual interest.

"Height Limits of Settlement in Japan" is a study based primarily upon the government topographic sheets on the scale of 1 : 50,000. Mr. Komaki finds that the general upper limit of permanent agricultural settlement lies at 1300–1320 meters' elevation. Here mulberry occupies about one-half of the arable area, and oats and potatoes are important crops. Pastures often lie immediately above this level and extend to 1400 meters. One small area of paddy was found at 1450 meters in the upper stream valley of the Chikuma River, and a stock farm in Nagano prefecture occupies a level of 1800 meters. These are the extremes. Mining communities largely disregard elevation. The Daikoku copper mine in the Kurobe district at 1840–1860 meters is the highest, and a sulphur manufacturing plant near Fukushima is at 1570 meters. In neither case is a large permanent population certain. Small shrine and temple settlements, many of them seasonal, some permanent, are common at high elevations. Mountain climbing by religious pilgrims is age old in Japan, and these religious settlements are often very ancient. More recently mountain climbing as a sport has become popular, and resthouses and resorts have sprung up: these houses and hot-spring resorts are also found at high levels.

"The 'Jori' as a System of Rural Planning" is a study that adds something more

to the already voluminous literature on what has generally been termed the Handen, or Chinese Land System. Mr. Yonekura contends that the Handen was most comprehensive and included all the essential factors of a scientific system of rural planning. This point is ably defended. He also claims that the Japanese had already developed a similar system of land division before the introduction of the Chinese method and that the adoption of the Handen only served to systematize the purely Japanese development. *Jo* and *ri*, measures of length and breadth, are combined to describe this plan and to differentiate it from any of the Chinese systems (Seiden, Senkyaku, or Kinden). There is little evidence, however, to prove it a native Japanese development, but whatever the adoption from China was it was so modified as to give it some claim to originality, and the term "jori" should meet with no great opposition.

"Rural Settlement Forms in Japan" includes a discussion of many specific forms and examples and also a number of general statements of great value in guiding settlement studies in Japan. Mr. Muramatsu holds that the study of settlement in Japan must progress by the study of individual districts and that general conclusions must wait upon the facts of these detailed studies. A primary step, he contends, is the consideration of which forces—geographical, racial, social, historical—determine agglomeration and which determine patterns of dissemination. Japan is essentially a land of agglomerations. Among the more important reasons for this are (1) the advantages of sites along *lignes de contact*, which are numerous throughout Japan; (2) the prevalence of economies requiring coöperation—rice cultivation and fishing; and (3) the need for protection in ancient days. Isolated farmsteads are common in the mountain lands and in areas of recent settlement. Mr. Muramatsu possibly holds more brief for the influence of the natural environment and less for historical and cultural explanations than do some other students of Japanese rural settlement.

R. B. HALL

The Evolution of Chinese Cartography. The earliest known maps of China are those engraved on stone and preserved in the Forest of Tablets at Sian in Shensi. The oldest of them appears to have been carved in 1137 A. D. and is based upon data from the ninth and third centuries. Rubbings of these stones are in the collections of the American Geographical Society, and the maps have been described by W. E. Soothill in the *Geographical Journal* (Vol. 69, 1927, pp. 532–555) and by Édouard Chavannes in the *Bulletin de l'École Française d'Extrême Orient* (Vol. 3, 1903, pp. 214–247). Woodcuts of small districts are to be found in many of the old County Gazetteers, or Hsien Chih, of which there are several thousands in the Library of Congress in Washington. These maps are usually local sketches with a pictorial treatment of the topography not unlike the modern physiographic diagram.

The precise cartography of China begins with the arrival of the Jesuits in the seventeenth century. Under the patronage of the Emperor Kang Hsi they undertook surveys and drew up maps of China as a whole and of the various provinces, which remained the basis of our knowledge until the twentieth century. Many present-day maps contain material that may be traced back to these sources. One of the best collections of the Jesuit maps is in Du Halde's "Atlas of the Chinese Empire" (1734 ?). A facsimile of one of the Jesuit maps in 104 sheets has recently been made by the Palace Museum in Peiping from the original copper plates rediscovered in 1925.

Shortly after the beginning of the present century the German and French war offices each began to issue a valuable series of maps on a scale of 1 : 1,000,000, overprinted with brown or gray to indicate relief. The German series for eastern China is now complete in 22 sheets, while of the French series entitled "Asie" there are now 15 sheets for China. The accuracy of these maps varies greatly with the in-

formation available. Missionaries' reports and travelers' journals appear to have been the guide for many interior areas. Certain rivers and cities are as much as a degree off, and provincial boundaries are doubtless even less dependable: yet these are the most detailed maps for many provinces. Of similar importance are the maps of the Geographical Section of the British General Staff. The earliest of these sheets were limited to a few provinces, but since 1925 important small-scale maps, based in part on aerial photographs, have been issued for the vicinity of some of the chief cities. The new 1 : 4,000,000 British maps of Asia in hypsometric colors (Geographical Section, General Staff, No. 2957) provide one of the best series for China as a whole and are useful either as atlas sheets or assembled as a wall map.

Maps of China based upon actual surveys are quite limited. The British General Staff is issuing a series of sheets at 1 : 20,000 with a ten-meter contour interval for Hongkong and the Kowloon Leased Territory (Geographical Section, No. 3868, 1928 and later), and the North China River Commission has published more than fifty sheets, with a five foot interval, of the drainage area behind Tientsin. Another series for the Peiping-Tientsin area is a French survey by Bouillard. Reference may also be made to the topographic maps of the Carnegie Institution's expedition to China in 1903–1904 under Bailey Willis and with R. H. Sargent as topographer. Coast and river charts, railroad surveys, and scattered astronomic locations complete the precise map data. There is urgent need for a triangulation net and a governmental program of surveys.

Since the establishment of the republic in 1911, the General Staff of the Chinese army has prepared a large number of sheets for various provinces, but unfortunately these maps are not generally available. Some represent reconnaissance surveys; others appear to be compilations from local sources.

Four maps have recently been published that supply further information on Chinese cartography. In 1933 the State Department at Washington issued a four-color map of China on a scale of 1 : 10,000,000 and another of Manchuria at 1 : 3,000,000, which have been carefully edited to show the current extent of railway construction and the more significant cities. Most maps of China are open to serious criticism because of the inclusion of unimportant towns or obsolete names. Unfortunately city names in China are subject to frequent change, but these maps conform to accepted usage and should have wide circulation for reference purposes.

In "China's Geographic Foundations" the writer has presented a three-color physiographic diagram, the first of its kind for China, which suggests the diversity and distribution of land forms in the eastern two-thirds of the country.

Within the past year two valuable contributions have appeared in China. Under the direction of members of the National Geological Survey at Peiping the leading Shanghai newspaper, the *Shun Pao*, has published a "New Atlas of Chinese Provinces" (Shun Pao Press, Shanghai, $2.50 Chinese). The volume contains 34 maps and a large number of inserts. There are separate maps for each of the 28 provinces, commonly on a scale of 1 : 3,000,000, and in addition maps of population, race, resources, climate, and communications. Of particular interest to many geographers are the small maps of cities, nearly fifty in number. The plates are in several colors and represent the best job of map printing that has yet appeared under Chinese auspices. The atlas is entirely in Chinese and is the forerunner of a large "New Map of China" shortly to appear.

The Chinese Post Office occupies a unique position, for it is the chief standardizing body for the romanization of Chinese city names. After an interval of fourteen years it has this year reissued the "Chinese Postal Atlas" with 29 maps for the various provinces (General Post Office in Shanghai, $12.00 Chinese). Roads and railways are included. Names are in English and conform to the spelling of the Post Office guide. The most recent issue of the "List of Post Offices" is the thirteenth, 1932 ($0.50 Chinese).

GEORGE B. CRESSEY

Polar Regions

"Arctica," **A New Magazine of the Arctic Institute of the U. S. S. R.** Under the able editorship of Professors R. L. Samoilovich and W. J. Wiese, the Arctic Institute of the U. S. S. R. (Leningrad) presents the first volume of *Arctica*. The new publication has a twofold function—to fill the demand for a nonperiodical organ to take care of those scientific contributions that are outside the scope of all the five periodicals issued by the Arctic Institute and to establish a better contact with the Arctic workers of other nations by placing its pages at their disposal. For the benefit of readers who do not understand Russian, summaries are given in some west-European language (in Esperanto in one case in this number). Judging by the selection and quality of the 15 articles covering the 190 pages of this first issue, there is no doubt that the new publication will make many friends.

Under the title "Andréev Land" Wiese gives a history of the 13 Russian expeditions that in the course of 200 years engaged in the exploration of the "white spot" to the west of Wrangel Island. After Wrangel in 1823 had declared the nonexistence of problematic Andréev Land no further attempts were made until 1911, when Russian ice breakers took up the problem. They succeeded in determining the western boundary of the "white spot," while the voyage of the *Maud* (1922–1923) limited it on the north. None of the theoretical arguments of Hedenström, Sverdrup, and Breitfuss permit of definite solution of the Andréev Land problem, but Wiese says that a final solution may come from aerial exploration in the near future.

Wiese also contributes an interesting account of the "Hydrology of the Pechora Sea in Winter." A rescue trip of the ice breaker *Krasin* provided the opportunity of obtaining the first data on record on winter conditions in this extreme southeastern part of the Barents Sea. The distinct stratification of the Arctic waters characteristic of summer conditions was found to have given way to an almost perfect homothermal and homohaline state due to vertical circulation and ice formation. These same causes are also responsible for a generally higher salinity, for a marked increase of alkalinity with depth, and for a frequent superposition of denser water on lighter water masses.

"Buried Glaciers in Cross Bay, Novaya Zemlya" by G. W. Gorbatzky describes a piece of physiographic research made during the Novaya Zemlya expedition of the Arctic Institute during 1931. The discovery and detailed study of many fossil glaciers around Cross Bay permit the writer to correct the statements of earlier investigators, especially as regards their climatological conclusions from the existence or absence of fossil peat bogs and of recent peat formations. Evidence is found that the glaciers now buried date back to the period of the last glaciation and must have descended directly to the sea in the days of their activity. Stress is laid on the geomorphological significance of these findings. The strandflat of Cross Bay, being subjected to heavy frost weathering, is gradually being transformed into karst topography, since the fossil glaciers rest chiefly on limestone.

Valuable contributions to the scant literature on Arctic fauna and welcome to the specialist are the articles "Some New Materials Adding to the Knowledge of Breeding Ranges and the Life History of the Eastern Knot, *Calidris tenuirostris* (Horsf.)" by Leonidas Portenko, "To the Knowledge of the Ichthyofauna of the Siberian Sea" by A. M. Popov, and "Brief Review of the Ichthyofauna of the Kara Sea" by W. K. Yessipov. These also reflect the aim of economic penetration of the vast expanses of polar territory within the domain of the U. S. S. R., as do two articles of more strictly economic character presented by I. I. Sokolov, one on "The Problem of Reindeer Husbandry on the European Islands of the Soviet Arctic," the other on "The Problem of the Arctic Dog." Reindeer culture is practically confined to three islands—Kolguyev, Novaya Zemlya, and Vaigach. Kolguyev easily holds first place with a herd of 10,000 head. Scarcity of pasture land, overgrazing, and adverse climatic conditions, especially glassy surface ice (*Glatteis*), seem to be the foremost

handicaps to rational reindeer husbandry. In the paper on the Arctic dog its superiority over the reindeer as a draft animal is pointed out, and the writer presents an interesting biological outlook on the evolution of the present species by interbreeding and adaptation.

K. A. Salishchev, geodesist and cartographer, contributes notes and suggestions for the systematic aerial survey of about four million square kilometers of uncharted Arctic territory for the purpose of constructing a 1 : 1,000,000 survey map by simplified methods. The same author also gives a historical review, with map (1 : 1,000,000) of the "Cartography of Wrangel Island" from the time Wrangel charted it from "native report" to 1932. An expedition originally planned as a relief expedition for the icebound islanders enabled the leader, the geologist Sergei Obruchev, in collaboration with Salishchev, to obtain a "relief" of Wrangel Island, which he describes in a brief article entitled "On the Orography of Wrangel Island."

Two shorter papers from the pen of an economic geographer, N. N. Urvantsev, conclude the first volume of *Arctica*. Both articles deal with the possibility of establishing transit ports for coal at the mouth of two Arctic rivers, the Lena and the Yenisei. A good digest of the "German Expedition to Greenland and Its Scientific Results" comes from the pen of editor R. L. Samoilovich, and there is one non-Russian contributor, Professor F. Debenham, director of the Scott Polar Research Institute of Cambridge, England, who reports briefly on the history and aims of his institution.

If the reader of *Arctica* is at first surprised at the variety and profusion of the material presented, he cannot fail to be also impressed by the practical interdependence of all these various phases of Arctic research carried on under the guidance and through the stimulus of the Arctic Institute, each of them finally contributing to a more intensive economic utilization of the Arctic shores, islands, and waters of the U. S. S. R.

H. A. BAUER

THE OCEANS

Oceanography of the South Atlantic Ocean. In connection with the study of whales and whaling in the Falkland Islands Dependencies, the Discovery Committee has been conducting oceanographic researches in the South Atlantic and Southern oceans since 1925. Detailed reports on the results of these researches are awaiting full analyses of the data; in the meantime, however, the Committee has issued, under the title "A General Account of the Hydrology of the South Atlantic Ocean," a brief summary report by G. E. R. Deacon on the oceanographic conditions in the region (Discovery Reports, Vol. 7, 1933, pp. 171–238).

In this report Mr. Deacon discusses the temperature, salinity, and oxygen, phosphate, and nitrate content of the waters of the South Atlantic Ocean. By treating the matter under the concept of different water masses, he presents an illuminating discussion of the physical features of the waters in this basin and of their interrelations. The temperature and salinity observations show that the surface layer of the South Atlantic Ocean consists of four kinds of water—an area of cold water of relatively low salinity in the Antarctic zone, an area of tropical water of high salinity in the vicinity of the equator, and two intermediate areas denominated respectively "sub-Antarctic" and "sub-tropical." In the Antarctic zone the surface layer has a depth of 300–800 feet, with a temperature and salinity of about 0° C. and 34‰ respectively. This overlies water with a temperature of about 1.5° and a salinity of 34.5‰. The surface layer arises from fresh water due to the melting of snow and ice, from the upwelling of warm water from the deeper layer, from the excess of precipitation over evaporation, and from the salt that is deposited when sea ice is formed. It extends from the Antarctic continent to about latitude 50° S. and serves to delimit the Antarctic region on the north.

North of this boundary the surface waters of the South Atlantic Ocean are characterized by a sharp increase in temperature of about 2.5° C. The subantarctic surface layer has a much greater depth than the Antarctic layer, and its temperature increases from south to north. Its salinity is somewhat greater than that of the Antarctic layer, and its northern limit appears to be in about latitude 40° S. The waters of this layer arise from the Antarctic surface waters, from the heavy precipitation in the subantarctic zone, and from the influx of subtropical water.

In the subtropical zone the surface water is much warmer and more saline than in the subantarctic water, having a temperature of about 20° C. and a salinity of about 35.5 ‰. The line between this water and that of the tropic zone is not well marked but may be taken to be at latitude 28° S. in the western half of the South Atlantic and at about latitude 12° S. in the east, where the Benguela Current carries the subtropical water northwards.

The deep waters of the South Atlantic Ocean are found to group themselves into three layers—an Antarctic intermediate layer, a warm deep layer, and an Antarctic bottom layer. The designations of these layers serve to indicate the origin of the waters of which they are formed. The Antarctic intermediate layer is distinguished by its low salinity and has its origin in the region just north of the Antarctic zone, which is a region of intense mixing. The warm deep layer has its origin in the southerly current that carries water from the North Atlantic Ocean to make up for the transport of water from the Antarctic in the surface and bottom currents that are directed to the north. This warm layer is underlain by the colder Antarctic bottom layer.

H. A. MARMER

WORLD AS A WHOLE AND LARGER PARTS

A Highway from Alaska to Argentina? A recent newspaper item notes that "with the Pan-American Highway to Santiago, Chile, nearing completion, interest has turned to a road from the United States to Alaska." Actually, of course, relatively little progress has been made on road construction southward from Mexico City that can be considered as contributing toward the realization of the long-standing dream of a land transportation system (by railroad or road) connecting the chief cities of North, Central, and South America. It is true that today one can travel by rail (with many changes and much inconvenience) through Mexico, Guatemala, and El Salvador to the Gulf of Fonseca, and (with as many changes but with rather greater convenience) from Cuzco, Peru, to Santiago, Buenos Aires, and the chief cities of Uruguay and southeastern Brazil. No part of these two long-distance routes was built, however, with an eye to an inter-American system, and in the intervening gap of more than 3000 miles not more than 650 miles of existing railway lines could be worked into sections of the main line of such a system.

The idea of an inter-American highway is relatively new, and the prospects for a road system that may eventually permit Canadians to drive in their own automobiles to Santiago, Buenos Aires, and Rio de Janeiro are certainly much better than are the prospects of their ever making the trip by a through rail route. An important step forward is the reconnaissance survey described on pages 353–370 of this number of the *Geographical Review*.

It would seem that the chief support for an inter-American motor highway system would come from the constantly growing number of persons in the United States and Canada who have learned the pleasure and convenience of vacation travel in their own automobiles and who are looking for new worlds to conquer. Figures of the tourist traffic in Canada are impressive. It is estimated that 12,750,000 visitors entered Canada by motor in 1928. Motorists contributed two-thirds of the revenue of over $250,000,000 derived from the tourist traffic from the United States (*The Round Table*, September, 1929, pp. 845–852). Automobile tourism is, of course, only

in the embryo stage in the Hispanic American countries on account of the present lack of long-distance motor routes, but that it is ready to spring into full bloom is evidenced by the astonishing number of automobiles in cities like Bogotá, Quito, and La Paz, where little use can be made of them outside the city streets. Another sign is the appearance of the first "Motorists' Guide to Mexico," 1933 (The South-West Press, Dallas, Tex.). The authors, Michael and Virginia Scully, report that early in 1933 "the Pan-American Highway, extending 768 miles from the Texas border at Laredo to Mexico City . . . consisted of 300 miles of paved roadway; 80 miles of lava rock surface as comfortable as pavement; approximately 330 miles of gravel, most of it hard-packed and ready for surfacing, and approximately 83 miles over which temporary roads were in use and the highway under intensely active construction."

The proposal of a road from the United States to Alaska appears both practical and possible of early achievement. The project was first given serious consideration in 1929, when international highway associations were formed at Fairbanks and Dawson for the purpose of arousing the interest of the Canadian and American public and coincidently the government of British Columbia began inquiries and exchanged views with officials in Alaska. In May, 1930, the United States Congress approved the appointment of a special commission to coöperate with Canadian representatives in a study of a feasible route and the cost of construction. The report of this commission (see Report of the Commission to Study the Proposed Highway to Alaska, 1933, *U. S. Dept. of State Conference Ser. No. 14*, Washington, 1933) proposes a route from Seattle to Fairbanks by way of Vancouver, Hazelton, Atlin, Whitehorse, and Dawson—a total of 2256 miles, of which 1073 miles (consisting of 52 miles of high-standard road from Seattle to Vancouver, 830 miles of good graveled road from Vancouver to Hazelton, a 50-mile section of the route from the Yukon boundary to the Alaskan boundary, and a 91-mile section of the route from the Alaskan boundary to Fairbanks) are already constructed. Of the total of 1183 miles to be constructed, 520 are in British Columbia, 480 in Yukon Territory, and 183 in Alaska.

HUMAN GEOGRAPHY

The Geography of Rural Settlements. A recent work edited by Fritz Klute on rural settlements in different parts of the world contains a methodological introduction by the editor and nineteen papers by German geographers (Die ländlichen Siedlungen in verschiedenen Klimazonen, Breslau, 1933). It is dedicated "dem Meister der Siedlungsgeographie, Professor Dr. Robert Gradmann." The papers deal with Norway, Italy, Bulgaria, Albania, Crete, Asia Minor, Australia, Canada, Brazil, and the Argentine, and with primitive settlements in the tropics. Although the title might seem to suggest some similarity to the coöperative volume "Pioneer Settlement" published in 1932 by the American Geographical Society, the point of view is different. In "Pioneer Settlement" interest is focused on communities of people, and the circumstances of the geographical environment are examined for the light that they may shed on pressing problems affecting these communities. In Klute's volume, which exemplifies a prevalent European approach, the objectives are more academic. Interest centers on the interpretation of *forms* of settlement—on tangible objects rather than on people and their perplexities. Social, economic, and political forces are considered, but only as they serve to explain material facts and relationships in the cultural landscape, notably: (1) the location of settlements, (2) the layout or plan of settlements (*Ortsplan*), and (3) the mode of construction of farm buildings and dwellings. For the several regions discussed the aim is to describe these elements and to estimate the extent to which each reflects the influence of physical environment, economic factors, stages of economic development, racial

characteristics, inherited traditions, or historical events. For example, to conditions of the physical environment—a rough topography and the scattered occurrence of patches of arable soil—are attributed in large part the widespread dispersion of farms and the infrequency of villages along the coast of Norway. In Italy an accentuated relief combined with complex historical causes is held responsible for pronounced differences in forms found within limited areas. The abandonment of zones along the seacoasts of Italy and Crete is interpreted as a historical legacy from the days of piratical raids. A peculiar social institution, the vendetta, is shown to have affected modes of construction in Albania, where many a farmstead is a towered stronghold. It is explained that German settlers in certain parts of Australia brought with them the Franconian farm and even the *Strassendörfer* and *Reihendörfer* typical of rural Germany (see also *Geogr. Rev.*, Vol. 21, 1931, pp. 682–683; for Italy, see the studies published under the title "Ricerche sui tipi degli insediamenti rurali in Italia" (a cura del Prof. Renato Biasutti). *Memorie Reale Soc. Geogr. Italiana*, Vol. 17, 1932, pp. 5–88; and for France, Albert Dauzat: Anciens types d'habitations rurales en France et dans les régions voisines, *La Nature*, No. 2884, July 1, 1932, pp. 1–5).

Miss M. A. Lefèvre, well known for her book and maps on rural habitations in Belgium (L'habitat rural en Belgique: Étude de géographie humaine, Liége, 1926; see *Geogr. Rev.*, Vol. 18, 1928, pp. 168–169), has contributed an important critical discussion of recent European investigations in this field to the *Bulletin de la Société Belge d'Etudes Géographiques* (Vol. 3, 1933, pp. 186–211). Miss Lefèvre stresses the need of more work of the kind now being conducted by, and under the inspiration of, Professor Albert Demangeon. Rural habitations must be subjected to close and rigorously objective study. They must be described in detail in small areas and classified on the basis of precise definitions. Distribution of types must be mapped. The terminology of the subject, especially, demands refinement.

For several European countries—notably Italy, Switzerland, Rumania, and Belgium—maps have been published showing the distribution of rural habitations in terms of their "arrangement"—to use a word suggested by M. Aurousseau (The Arrangement of Rural Populations, *Geogr. Rev.*, Vol. 10, 1920, pp. 223–240; see also *Geogr. Rev.*, Vol. 11, 1921, pp. 612–614). All these maps disclose not only several gradations between extreme concentration in villages and extreme dispersion on isolated farms but also distinctive types of arrangement, such as "villages and hamlets of the Alpine type," "vineyard and chestnut-grove type, with many small compact villages," etc. Such maps are necessarily based on more or less subjective and personal criteria and hence are not directly comparable with one another (see R. Biasutti: La carta dei tipi di insediamento, with map, 1 : 2,000,000, *Memorie Reale Soc. Geogr. Italiana*, Vol. 17, 1932, pp. 5–25; Charles Biermann: L'habitat rural en Suisse, with map, 1 : 1,400,000, *Bull. Soc. Neuchâteloise de Géogr.*, Vol. 41, 1932, pp. 5–40 (a similar map will be found in J. Früh: Geographie der Schweiz, Vol. 2, St. Gall, 1932, opp. p. 536); Vintilă Mihăilescu: O hartă a principalelor tipuri de aşezări rurale din România, with map, 1 : 3,000,000, *Bul. Soc. Regale Române de Geogr.*, Vol. 46, 1927, pp. 62–75; Lefèvre, L'habitat rural en Belgique, with maps, 1 : 625,000).

In order to eliminate the subjective element as far as possible Demangeon has proposed a method of statistical analysis as a basis for the cartographic representation of relative degrees of concentration and dispersion in France. The requisite statistics for such studies must be of far greater refinement than those published by the U. S. Census Bureau. As regards Italy, population figures for 1931 are available for every hamlet or group of dwellings, however small (Biasutti, La carta dei tipi di insediamento, p. 6), and comparable figures may be had for France. Demangeon has prepared specimen maps of the department of the Somme and of the vicinity of Belfort on which is plotted a "coefficient of dispersion" for each commune. The maps reveal interesting correlations between the degree of dispersion and various

elements of the physical environment (A. Demangeon: Une carte de l'habitat, *Ann. de Géogr.*, Vol. 42, 1933, pp. 225–232). A substitute for Demangeon's coefficient has been proposed by Aldo Sestini, in a pointed critique of his method (*Riv. Geogr. Italiana*, Vol. 40, 1933, pp. 189–193).

Postscript. Since the above note was set up in type Volume 3 of the reports of the proceedings of the International Geographical Congress held at Paris in 1931 has been received. The first 315 pages are devoted to the rural habitation and contain some of the above mentioned papers and a number of others, together making a collection notable for its variety and interest.

HISTORY OF GEOGRAPHY

Historical Geography at Recent International Congresses. At all the International Geographical Congresses that have been held in late years the historical phases of geography have received extended discussion. Nor will they be neglected at the Congress that meets at Warsaw this summer, where a "Section of Prehistoric Geography, Historical Geography, and the History of Geography" will give particular consideration to such problems as the reconstruction of the geographical conditions of prehistoric habitation, changes in the geographical landscape in historical times, and unpublished and rare cartographical documents.

Historical geography has also been represented at recent international gatherings of historians, notably at the Sixth and Seventh International Congresses of Historical Sciences, held respectively at Oslo in 1928 and at Warsaw in 1933, and at the First International Congress of Historical Geography, which met in Belgium in 1930.

The main purpose of the last-mentioned congress, as announced in a preliminary circular, was to enable "historical workers to coordinate their efforts and to come to an international agreement as to the rules to be applied to the elaboration of works of historical cartography." The Congress was divided into seven sections (the references in parentheses are to representative subjects discussed at the meetings of the sections): Physical Geography (the rôle of marshes in English history; land areas of the Netherlands reclaimed from, and submerged beneath, the water during the last thousand years); Political Geography (early boundaries in Anglo-Saxon England); Ecclesiastical Geography (map of the ancient church province of Cambrai in 1559); Rural and Urban Geography (urban decentralization in Brussels; is there a historical geography of human habitations?); Linguistic Geography (the recession of Flemish in northern France since 1806); Means of Communication (the "turquoise route" in ancient Egypt and the Sinaitic alphabet); Historical Topography (scenography of primitive peoples and their successors considered as a branch of modern topography). To questions of methodology much attention was directed. Professor F. Curschmann of Greifswald in discussing "Problems of Historical Geography and Recent German Historical Atlases" pointed out that contemporary German students in this field regard themselves as disciples of Eduard Richter, formerly professor of geography at Graz, who in 1895 initiated work upon the "Geschichtliche Atlas der österreichischen Alpenländer." The essential point in Richter's method is to work backward chronologically from "the accurately known present or recent past" to earlier times (1er Congrès International de Géographie Historique, Vol. 2, Brussels, 1931, p. 35).

In connection with the Seventh International Congress of Historical Sciences, which met at Warsaw in August, 1933, an important exhibition of maps was held. The exhibits were prepared through the activity of a Commission of Historical Geography of the International Committee of Historical Sciences. Three main subjects were covered: (1) the historical development of "special" maps, (2) historical maps, and (3) the territorial development of cities. Although most of the "special" maps and plans of cities were either originals or reproductions of topographical maps and

plans dating from before 1800, a considerable number of maps showing other than topographical features—such as marine charts, maps of ecclesiastical divisions, military maps, etc.—were also on display. The exhibition was intended primarily to demonstrate the value and uses of maps as original sources of historical research, and consequently no attempt was made to emphasize maps illustrating the growth of geographical science and of cartography as such. The second section, "Historical Maps," consisted of maps and atlases designed by historians to illustrate historical events and conditions that prevailed in former times. The exhibition was of particular value for Germany, Belgium, Holland, Italy, and Sweden. The exhibits are described in detail in a 311-page annotated catalogue, which should be of permanent value to cartobibliographers (Catalogus mapparum geographicarum ad historiam pertinentium, Warsaw, 1933; see also *Annales d'Hist. Écon. et Sociale*, Vol. 6, 1934, pp. 154–157).

OBITUARY

Douglas William Freshfield. Douglas William Freshfield, the distinguished British explorer of mountains, died on February 9 in his eighty-ninth year. He was one of those who, to use his own phrase, "count among the glories of the world" the great mountains. His record in the Alpine Club Register is impressive—the Alps, the "frosty Caucasus," the Himalayas, even the "Mountains of the Moon" (Ruwenzori) came within his scope. "The Exploration of the Caucasus" (2 vols., 1896) and "Round Kangchenjunga" (1903) are splendid souvenirs of his two most notable achievements. He was, however, no mountaineer of "the stricter doctrine." In that charming volume "Below the Snow Line" (1923) he confesses to being as much a traveler as a climber. One may add that he traveled always with the curiosity of the scholar and the eye of the poet. The nicety of his scholarship finds expression in his classic biography of De Saussure.

Mr. Freshfield was actively associated with the Royal Geographical Society as well as with the Alpine Club. In his association with the former he "rendered noble service to the science of geography by his encouragement of research and of higher education . . . he initiated an inquiry into the state of geographical teaching on the Continent and secured the appointment of the late Sir John Keltie for that purpose. The resulting report started the modern revival in British geography" (H. R. Mill in *Nature*, March 10, 1934, p. 351). He served for many years as president of the Geographical Association. Memorial notices appeared in the April number of the *Geographical Journal* and the May number of the *Alpine Journal*.

James Mackintosh Bell. James Mackintosh Bell, the Canadian geologist and explorer, died at his home in Almonte, Ontario, on March 31, at the age of 56. Dr. Bell had a wide knowledge of his native land and of many far places. To quote from the *Canadian Geographical Journal* (April, 1934, p. 197): "Long before Great Bear Lake was anything more than a name to all but a handful of fur-traders, he and his friend Charles Camsell had explored the coasts of that vast inland sea, and the rivers that flowed into and out of it. He had travelled over many little-known parts of Siberia and Central Asia, and, because of his lively interest in the things that he saw, and also because of his unusual gift for languages, brought away with him far more than the average traveller could hope to gather." A recent product of his travels is the interesting volume "Far Places" (1931), with its vivid accounts of experiences in the Canadian Northwest, in New Caledonia, in the Kirghiz steppes, in Jamaica and Albania. The data for his volume "The Wilds of Maoriland" (1914) were acquired during his directorship of the Geological Survey of New Zealand (1905-1911). At this time he contributed the paper "A Physiographic Section Through the Middle Island of New Zealand" to the *Bulletin of the American Geographical Society* (Vol. 38, 1906, pp. 273–281). Another of the many papers con-

tributed to scientific journals was "Great Slave Lake" (*Geogr. Rev.*, Vol. 19, 1929, pp. 556–580).

Of late years Dr. Bell had become increasingly interested in the geographical aspects of his work, and he was one of the founders of the Canadian Geographical Society.

Carsten Egeberg Borchgrevink. Carsten Egeberg Borchgrevink, the Antarctic explorer, died at Oslo on April 21, aged 69 years. Mr. Borchgrevink's first venture into the Antarctic was on a whaling vessel in 1894. On this occasion a landing was effected at Cape Adare, and Mr. Borchgrevink made the first discovery of plant life within the Antarctic Circle (see report in *Journ. Amer. Geogr. Soc.*, Vol. 27, 1895, pp. 295–298). He returned to this region as leader of the British Antarctic Expedition on the *Southern Cross*, 1898–1900. His expedition was "the first to winter on Antarctic land, the first to land upon and travel over the great Ice Barrier, and the first to obtain definite proof of the recession of the Barrier ice since its margin was charted by Ross" (see the remarks of the President of the Royal Geographical Society on presenting the Patron's Medal to Mr. Borchgrevink, *Geogr. Journ.*, Vol. 76, 1930, p. 181). The story of the expedition is told in his book "First on the Antarctic Continent" (1901).

George Byron Roorbach. George Byron Roorbach, professor of foreign trade at the Graduate School of Business Administration, Harvard University, died in Washington on May 23, aged 55 years. For some time past Dr. Roorbach had been acting as special adviser to the State Department on foreign trade matters. Tribute to his services has been paid by Secretary of State Cordell Hull. During the War, Dr. Roorbach, then assistant professor of economic geography at the University of Pennsylvania, investigated for the Carnegie Endowment the effects of the war upon industrial and trade conditions in Venezuela; later he was with the Division of Planning and Statistics of the United States Shipping Board. During 1921–1922 he served as Chief of the Division of Statistical Research of the United States Bureau of Foreign and Domestic Commerce and for two summers as special expert with the United States Tariff Commission. He spent 1926–1927 in the Orient studying Far Eastern international trade. He had been treasurer and vice-president of the Association of American Geographers. In addition to numerous articles on subjects pertaining to economic geography and international trade, he was the author of "Import Purchasing: Principles and Problems" (Chicago, 1927), "International Competition in the Trade of India" (Carnegie Endowment for International Peace, 1931), "Problems of Foreign Commerce" (New York, 1933), and "The Importance of Foreign Trade to New England" in "New England's Prospect: 1933" (*Amer. Geogr. Soc. Special Publ. No. 16*, 1933).

GEOGRAPHICAL REVIEWS

Britain and the Empire

C. B. Fawcett. **A Political Geography of the British Empire.** xiii and 409 pp.; maps, diagrs., index. Ginn and Co., Boston, New York, etc., 1933. $4.50. 9 x 6 inches.

L. Dudley Stamp and Stanley H. Beaver, with contributions by Sir Josiah Stamp and D. K. Smee. **The British Isles: A Geographic and Economic Survey.** xii and 719 pp.; maps, diagrs., ills., index. Longmans, Green and Co., London, New York, Toronto, 1933. $8.00. 9 x 6 inches.

The British Empire is unquestionably one of the most extensive and complicated institutions that men have ever created. Its parts are so scattered and its resources, peoples, governments, and problems are so diverse that the whole may well appear lacking in coherence and rationality. Professor Fawcett's main purpose is to show that the Empire is not without rhyme or reason. He undertakes the difficult task of explaining "those geographical facts which are of direct importance in their influence on the [Empire's] development and organization" and on the whole succeeds remarkably well in carrying out this task, thanks to skill in selecting and combining data of large significance together with ability in making broad and illuminating statistical comparisons.

The lands, peoples, and governments of the Empire are systematically classified and interpreted in a series of introductory chapters. Each one of the principal divisions is then discussed separately. Enduring political and administrative problems are analyzed in relation to climate, relief, soils, minerals, distribution and composition of population, etc. The location of the several dominions, colonies, and dependencies with respect to the rest of the Empire and to other parts of the world is explained and illustrated by means of maps drawn on an ingenious projection. The element of geographical position is emphasized throughout.

With the exception of India, the Empire as a whole is thinly peopled. Among its principal problems are those of future settlement and the development of hitherto little used resources. Fawcett estimates the "population-capacity" of Canada at 100,000,000, that of Australia at 50,000,000, and that of New Zealand at 20,000,000. "The equatorial and tropical regions of the world are . . . so far from being fully exploited at present that the time when the pressure on their resources will be so great as to justify interference with Australia's experiment [i.e. the maintenance of a 'White Australia'] is as yet very distant."

That full and satisfactory use is not today being made of the natural resources of even the British Isles themselves is the main thesis of Stamp and Beaver's comprehensive book. Professor Stamp points out in the preface that Britain "is, to a considerable extent, still suffering from an insidious and widespread disease . . . the '1914 mind.' There is still the idea that when the world settles down to 'normal' conditions once more those normal conditions, especially in relation to world trade, will in some ways resemble conditions in 1913–14." "The British Isles" shows how false this view is. National economy must be adapted to the realities of the present rather than to memories of the past. Less implicit and more enlightened reliance must be placed upon the shifting currents of oversea trade. If European markets for British coal have vanished, other markets must be sought in countries now deficient in coal and poorly served by Britain's competitors. Better use must be made of internal resources. Waste lands must be afforested and more care taken of existing woodlands. It is "little short of a scandal" that a country as admirably adapted to timber growing as the British Isles should stand at the bottom of the list of European nations as regards forest area per capita and in proportion to total area. With

improvements in agriculture, aided by coöperation, the soil could be made to produce 50 or even 100 per cent more than it now produces. Even in their consumption of fisheries products the British people are failing to make the most of unsurpassed opportunities offered by seafaring traditions and nearness to some of the richest fishing grounds of the world.

"The British Isles" is almost encyclopedic in scope. Such observations and opinions as those just stated emerge more or less as by-products from a mass of important and useful, if somewhat discrete, information. The authors begin with the position of Britain and with the physiography, climate, inland waters, soils, natural vegetation, and land utilization of the British Isles. They devote by far the greater part of their attention to agriculture and to the different mining and manufacturing industries. Toward the close of their volume they take up population, the history of settlement, communications, seaports, and foreign trade. Sir Josiah Stamp contributes a brief discussion of the "National Capital." Many of the chapters are in the nature of statements of the results of recent research concerning particular topics, and useful bibliographical "leads" are furnished. Agriculture is dealt with both in general terms and in terms of agricultural regions. There is a chapter on the industrial regions of Ireland but none on the industrial regions of Great Britain, although suggestions are given concerning the latter.

Labrador, Romantic and Workaday

Sir Wilfred Grenfell. **The Romance of Labrador.** xiv and 329 pp.; ills. The Macmillan Co., New York, 1934. $4.00. 8½ x 6 inches.

Elliott Merrick. **True North.** 353 pp.; map. Charles Scribner's Sons, New York, 1933. $3.00. 8½ x 6 inches.

J. M. Scott. **The Land That God Gave Cain: An Account of H. G. Watkins' Expedition to Labrador, 1928–1929.** vii and 282 pp.; maps, ills., index. Chatto and Windus, London, 1933. 12s. 6d. 9 x 6 inches.

In 1909 Dr. Grenfell and his collaborators produced the classic volume "Labrador: The Country and the People." New editions appeared in 1913 and 1922. Now in "The Romance of Labrador" Dr. Grenfell gives us a work "for popular consumption." The country and the people are presented in a series of pageants, starting with the "pageant of the rocks" and proceeding through pageants of Indians, Eskimos, Vikings, the "Big Four" (Columbus, Cabot, Cortereal, and Cartier), the French, the English, the Moravian Mission, and the animal and plant life to a survey of the last 40 years and the considerable changes wrought therein for which Dr. Grenfell himself has had no little responsibility. The wild and beautiful land lends itself well to this picturesque style of treatment, though certain difficulties are inevitably encountered when departure is made from description to scientific explanation. Many fine photographic illustrations enrich the volume, including some aerial pictures from the Grenfell-Forbes North Labrador Surveying Expedition (cf. Alexander Forbes: Surveying in Northern Labrador, *Geogr. Rev.*, Vol. 22, 1932, pp. 30–60; also see the note, p. 488 of this *Review*).

Dr. Grenfell's love for his adopted country is undoubtedly shared by most of the many helpers who have participated in the work of his mission. The fascination of the land is communicated with extraordinary feeling by Elliott Merrick in "True North." "It is the land, the long white lakes, the forests and mountains and rivers, the space and the northern lights and the cold and beauty." Mr. Merrick and his wife, former teacher and nurse respectively at the Northwest River station, traveled 350 miles up Grand River with trappers on their annual autumn trip " 'into the country' to the furring grounds." The journey, made in 1930, included a trip to the Unknown Lake (Ossokmanuan) and to the falls of the Unknown River. They

went in by canoe and came out by snowshoe on a route traveled by few outsiders. But the Merricks can hardly be considered outsiders, so thoroughly did they enter into the life of the country and its people. Their adventure was no less an adventure of the spirit, and it illuminates the other side of "a lonely, toil-bitten existence in a cruel land." " 'It was a glimpse into a life we never knew before. It is unbelievable what a trapper can accomplish. We knew before that they were remarkable men, but now we know they are supermen.' " And in the words of one of them: " 'You know, b'y, I never seen outside where you comes from. But I finds this pretty good—the country and the huntin' and all. I wouldn't want to go and live away. Sometimes I thinks, me, we'm happy here.' "

J. M. Scott's book, on the contrary, is of the country as seen by an outsider—a straightforward, good-humored narration. With Mr. H. G. Watkins, Mr. Scott made three principal excursions—south through the Mealy Mountains, north via the Naskaupi and out to the coast at Hopedale, west to the Grand Falls and the Unknown River and its falls. These accomplishments were described in the *Geographical Journal* (H. G. Watkins: River Exploration in Labrador by Canoe and Dog Sledge, Vol. 75, 1930, pp. 97–122). Mr. Scott's present narrative must be considered as in part a tribute to the young leader who found here a good training ground for the larger adventure in Greenland.

Agricultural Problems of Central Europe

O. S. Morgan, edit. **Agricultural Systems of Middle Europe: A Symposium.** xix and 405 pp.; maps, bibliogrs. The Macmillan Company, New York, 1933. $5.00. 9½ x 6½ inches.

Going upon the assumption that the agricultural problems of the Middle European countries can best be dealt with by native specialists, Professor Morgan persuaded Dr. Leopold Hennet and Dr. Anton Steden of Austria, Professor J. S. Molloff of Bulgaria, Professor T. Vladislav Brdlík of Czechoslovakia, Mr. Georges Servakis and Dr. C. Pertountzi of Greece, Dr. Iván Edgar Nagy of Hungary, Dr. Waclaw Ponikowski and Dr. Victor Leśniewski of Poland, Dr. A. Frundianescu and Professor G. Ionescu-Sisesti of Rumania, and Dr. Velimir N. Stoykovitch of Jugoslavia to write, on the basis of the following standard outline, factual chapters of some 20,000 words each on certain aspects of the individual countries: (1) physical factors—latitude, climate, topography, soils; (2) population—especially agricultural population; (3) land utilization—forests, pastures, crops, waste; (4) brief history of agriculture, 1918–1931; (5) land reform—estates, strip farming, consolidation; (6) production and techniques—mechanization; (7) marketing and marketing program—export and import regulations, price stabilization, transportation; (8) agricultural coöperation of various sorts and sizes; (9) taxation, insurance (especially interest rates); (10) agricultural education, including popular; (11) farmers in politics—farmers' unions or societies; (12) farmers' income—gross, net; (13) outlook for agriculture and farmers; (14) special economic developments not included in above; (15) Pan-Europa, customs unions, etc.; and (16) appendixes—brief bibliography, statistical tables.

There can be no doubt that there is a definite need for a volume of this kind. The subject selected is of great importance for several reasons. In nearly every case the economic structure of these countries depends on agriculture, and several of them have undergone a reconstruction of their agricultural policies since the World War. From another viewpoint several of these countries present a serious competition to American agriculture in European agricultural markets. Furthermore, "the editor has another though marginal reason for selecting these countries, namely, a conviction that agricultural rehabilitation in Europe is more likely to develop in and pivot around these countries as an economic unit than in or around countries that are more stable politically or economically, or both."

Taking the whole symposium as a unit, we have here a vast store of material from which the superfluous has been eliminated. The book is packed with facts, based on wide research, and presents a clear and straightforward picture of its subject. But it must be admitted that many details are not new and have appeared in other forms in the English language. On the other hand, there is no other publication in the field that can boast of such a convenient compilation in one volume.

In spite of its excellency of approach and treatment, the publication has one serious defect. The collaborating authorities are or have been either state ministers of agriculture or officials high in the national agricultural administration. Their official connections were probably the reason for their failure to treat adequately the chapters dealing with the participation of peasants in politics. For example, there is not even a mention of Stambuliski in connection with Bulgaria, and the whole subject of the Agrarian party in that country is disposed of in 19 lines.

A minor criticism can be directed against the many misspellings. Thus on page 136 "Bradlík" should be spelled "Brdlík" and "Voženílek" substituted for "Vozenilez." But in spite of its defects the work provides an illuminating prelude to any study of the Central Europe of today.

JOSEPH S. ROUCEK

MODERN AND ANCIENT ARABIA

D. VAN DER MEULEN AND H. VON WISSMANN. **Ḥaḍramaut: Some of Its Mysteries Unveiled.** xxvi and 248 pp.; maps, ills., index. (Printed for the Trustees of the "De Goeje Fund," No. 9.) E. J. Brill, Ltd., Leyden, 1932. 9½ x 7 inches.

HANS HELFRITZ. **Chicago der Wüste.** 176 pp.; map, ills. Reimar Hobbing, Berlin, 1932. 9 x 6½ inches.

RAYMOND PHILIP DOUGHERTY. **The Sealand of Ancient Arabia.** xii and 203 pp.; index. (Yale Oriental Ser.: Researches, Vol. 19.) Yale University Press, New Haven; Humphrey Milford, Oxford University Press, London, 1932. $3.00. 10 x 7½ inches.

H. ST. J. B. PHILBY. **The Empty Quarter; Being a Description of the Great South Desert of Arabia Known as Rubʿ al Khali.** xxiv and 432 pp.; maps, ills., index. Henry Holt & Co., New York, 1933. $4.00. 9 x 6 inches.

In "Ḥaḍramaut" Mr. van der Meulen, formerly *chargé d'affaires* for the Netherlands at Jidda, entertainingly narrates a six weeks' journey in southern Arabia in the spring of 1931 in company with Dr. von Wissmann as cartographer (see also D. van der Meulen: Into Burning Hadhramaut, *Natl. Geogr. Mag.*, Vol. 62, 1932, pp. 387–429). Von Wissmann, whose interpretation of the physical geography of Arabia has already been noted in these columns (*Geogr. Rev.*, Vol. 23, 1933, p. 332), contributes "the first map [1 : 250,000] of Ḥaḍramaut, based on measurements and surveying." (It may be noted parenthetically that the earliest Occidental traveler's journey in Ḥaḍramaut of which we have a record was that of the Portuguese Jesuit, Pero Paez, in 1590. See A. Kammerer: Le plus ancien voyage d'un occidental en Hadramaout (1590) . . . . , *Bull. Soc. Royale de Géogr. d'Égypte*, Vol. 18, 1933, pp. 143–167.)

The interior of Ḥaḍramaut is a land of high plateaus, which attain a maximum elevation of 7088 feet. Horizontal strata of sedimentary rocks are capped by limestones over wide areas. The upland surfaces, known as *djōl*, are desolate to an extreme, but, as in northern Arizona and New Mexico, the plateaus are dissected by ramifying, steep-walled canyons, on whose floors the settlements lie. The towns are compactly constructed. Most of the houses, typical of the distinctive architecture of southern Arabia, rise to heights of four or five stories, and some of the palaces are even loftier, reaching heights of ten to fourteen stories. Hans Helfritz,

a young German who visited Ḥaḍramaut shortly after the journey of Van der Meulen and Wissmann, likens the town of Shibām, with its towering buildings, to a "Chicago of the Desert." Helfritz's volume is essentially a collection of photographs of rare distinction. Some of these illustrate the remarkable architecture of the Ḥaḍramaut towns; others are striking "close-up" portraits of typical townsfolk and Bedouins. In 1933 Helfritz made a notable trip from Wādī Ḥaḍramaut across the fringes of the desert to San'a in Yemen (*Petermanns Mitt.*, Vol. 79, 1933, p. 307).

Until Van der Meulen's expedition the interior of Ḥaḍramaut could still be classed among the least-known settled regions of Arabia. The visits of earlier Europeans number hardly more than half a dozen. This neglect, resulting in part from the fanaticism of the people and in part from the divided authority of their rulers, seems doubly remarkable when we consider that, of all peoples of Arabia save the Meccans, the Ḥaḍramīs are probably the most prosperous and maintain the closest contact with the outside world. They have emigrated in large numbers to the East Indies, where some of them have amassed fortunes. A Ḥaḍramī of high rank is, or has been, owner of the Grand Hôtel de l'Europe in Singapore. Many of the emigrants return to their native canyons to live at ease and in comparative luxury during their declining years. Here they have built handsome palaces amidst well kept gardens. At Shibām and Terīm swimming pools have been constructed, one fed by water pumped from 45 feet below the surface by a Deutz motor. Automobiles belonging to the wealthy sayyids, or descendants of the Prophet, are a common sight not only in the coast town of Makalla but also in the isolated oases of the Wādī Ḥaḍramaut. At the time of Van der Meulen's visit an automobile road was under construction connecting Terīm with the port of esh-Shiḥr. To maintain friendly relations an agreement was concluded with the Bedouins whereby the road is to be used for passenger traffic only, all freight to be carried by the camels of the nomads.

It is a far cry from this Arabia of today to the Arabia of the late Professor Dougherty's book. Cuneiform inscriptions make frequent mention of conflicts between the Babylonian and Assyrian kings and the powerful rulers of a region known as the Sealand. From the time of Sargon of Agade (twenty-sixth century before Christ) until the conquest by the Persians (539 B.C.) "the Sealand had to be reckoned with, at least periodically, in Babylonian and Assyrian affairs." The Chaldean (or Neo-Babylonian) empire, which destroyed the power of Assyria toward the end of the seventh century, was apparently of Sealand origin. The orthodox view among Assyriologists has been that the Sealand was a small strip of country comprising the marshes around the head of the Persian Gulf. Dougherty argues that a much larger area must be postulated adequately to account for the continued strength that the Sealanders manifested throughout two millenniums He presents a new thesis—that the Sealand included not only the vicinity of the Persian Gulf but also a large part of northern Arabia. In support of this he brings together scattered historical evidence supplemented by geographical evidence to the effect that northern Arabia in early historical times was a better watered and more productive country than is now the case and that the Persian Gulf may have extended into this region. However we may regard the historical argument, some of the geographical evidence certainly seems a little strained. The finding by Philby of Jurassic marine fossils can have no real bearing on the case, nor does the fact that Doughty, Philby, and other travelers liken the sand dunes of the deserts to waves of the sea seem to support in any substantial way the argument that Arabia may have been called "Sealand." Professor Dougherty was an adherent of Caetani's view that "considerable variation in climate has been a definite factor in the history of Arabia." This may be true, but the opinion has not gone unchallenged, notably by Musil, to whose discussion of the subject Dougherty makes no reference (Alois Musil: The Alleged Desiccation of Arabia and the Islamic Movement, in his "Northern Neǧd," *Amer. Geogr. Soc. Oriental Explorations and Studies No. 5*, New York, 1928, pp. 304–319).

In "The Empty Quarter" H. St. J. B. Philby tells the story of his great expedition through the northern part of Rub^{c} al-Khali in 1932. This has already been commented on in the *Geographical Review* (Vol. 23, 1933, pp. 332–333). The volume includes notes by members of the staff of the British Museum and others on the geological and biological collections made in the course of the journey. Perhaps the most striking single discovery was that of fragments of silica glass in unprecedentedly large quantities about the meteorite craters of Wabar. This glass was produced by the fusion of desert sand resulting from heat generated by the impact of the falling meteoritic masses.

The Geography of China

George Babcock Cressey. **China's Geographic Foundations: A Survey of the Land and Its People.** xvii and 436 pp.; maps, diagrs., ills., bibliogr., index. McGraw-Hill Book Company, New York and London; Maruzen Company, Tokyo, etc., 1934. $4.00. 9 x 6½ inches.

George B. Cressey. **The Ordos Desert of Inner Mongolia.** Maps, diagr., ills., bibliogr. *Denison Univ. Bull., Journ. of the Sci. Laboratories*, Vol. 28, 1933, pp. 155–248.

George B. Cressey. **Agricultural Regions of Asia: Part VI—China.** Maps, ills. *Econ. Geogr.*, Vol. 10, 1934, pp. 109–142.

"China's Geographic Foundations" is a sincere and useful contribution to geographical literature. Its author has lived a number of years in China and has traveled through most parts of the country. He has acquired a genuine feeling for the quality and continuity of its life: "a long moving picture . . . The Chinese landscape is vast in time as well as in area . . . More human beings have probably lived on the plains of China than on any similar area on Earth. Literally trillions of men and women have made their contribution to the contour of hill and valley and to the pattern of the fields. The very dust is alive with their heritage." The chapter on "The Geographical Landscape," from which this quotation is taken, and five other general chapters provide an introduction to the main body of the book—the description of the fifteen regions into which Dr. Cressey divides the country. Among outstanding features are the illustrations: 197 numbered figures, the greater number photographs well selected and well reproduced, and a physiographic diagram in color on a scale of 1 : 12,120,000. There are 36 tables, including a valuable statistical summary with data worked out by geographical regions. Use has been made of recent work in many fields—C. F. Shaw's work on soils, J. Lossing Buck's studies in agricultural economics, the mineral researches of the Geological Survey of China, the meteorological studies of Coching Chu and Father E. Gherzi, for instance. The chapter on topography is somewhat perfunctory; the section on the mechanics of China's climate contains that unfortunate expression of the "partial vacuum"; there is a perhaps inevitable tendency to the encyclopedic; but the volume as a whole is praiseworthy in its conception and execution.

"The Ordos Desert of Inner Mongolia" deals monographically with a part of one of the fifteen regions (the Central Asiatic Steppes and Deserts). The area, nearly the size of New England, is enclosed between the Great Wall and the great bend of the Yellow River. It is, perhaps, specially interesting on the human side as a borderland of Chinese agricultural penetration, and Dr. Cressey has a good deal to say on the "Sons of Han in the Land of Grass." "The entire Mongolian borderland is an area of precarious agriculture. Irrigation can modify but one of the unfavorable factors of the environment, and on un-irrigated fields harvests are conditioned upon favorable precipitation. Except for the districts along the Hwang Ho, the agricultural possibilities of the region are rigorously limited." The caption of one of the

illustrations runs: "Due to drought and bandit raids, only fifteen per cent of the houses south of Paotowchen were occupied in 1928."

The agricultural regions of China are the subject of Dr. Cressey's contribution in the April number of *Economic Geography*. He uses his geographical regions as the basis of the discussion and also makes comparison with the agricultural regions in "Cropping Systems and Regional Agriculture in China" (U. S. Bureau of Agricultural Economics) by Paul O. Nyhus, reproducing Nyhus's map and quoting from his report, which is available only in mimeographed form.

The Climate of China

B. Burgoyne Chapman. **The Climatic Regions of China.** 77 pp.; maps, diagrs., bibliogr. *Univ. of Nanking College of Agriculture and Forestry Bull. No. 3 (N.S.)*, 1933. 9 x 6 inches.

This bulletin provides a most useful guide to the climate of China, especially as it relates to agriculture. The 77 pages are full of both data and ideas, but withal due caution is expressed: "The constant danger is that we may forget the extent of our ignorance." The report includes rainfall data for 145 stations and temperatures for 92 stations, together with numerous maps, which unfortunately are not well drawn. The study is based upon the climatic data of Zikawei Observatory near Shanghai, the regional studies of Dr. Coching Chu of the National Research Institute of Meteorology at Nanking, and variability studies of Miss Liu En-lan of Ginling College.

Several significant features of China's climate are too often overlooked, such as the continental cyclonic storms that move eastward down the Yangtze Valley, the comparative reliability of the rainfall in the South and its variability in the North, where it rises to 40 per cent at Peiping, and the duration of the growing season. Chapman defines nine climatic regions, the growing seasons for which are as follows: The South, 365 days; Southeastern Hills, 304 days; Southwestern Plateaux, inadequate data; Red Basin, 329 days; Lower Yangtze, 295 days; Northern Plain, 240 days; Northern Highlands, 189 days; Manchuria (part) and Jehol, 200 days; and the North and West, 180 days.

George B. Cressey

Japan Seen Through Its Ports

L. Mecking. **Japans Häfen, ihre Beziehungen zur Landesnatur und Wirtschaft.** 592 pp.; maps, diagrs., ills. *Mitt. Geogr. Gesell. in Hamburg*, Vol. 42, 1931.

For geographers whose special field of interest is the Far East, Mecking's monographic study of Japan through the medium of its ports is one of the most valuable contributions on the geography of Nippon in a European language. Japan's development is most intimately associated with the sea, so that a study of that nation's ports and their hinterlands becomes a more complete geography of the country than such a study of most nations would be. The author spent five months in Japan during 1926, in which time he visited and studied all the important ports of Old Japan.

The two parts of the volume differ in their size and organization. Part 1 (pp. 19–219) is more general in its content and deals with the country as a whole. Part 2 (pp. 221–592) is a detailed analysis of the individual ports of the country. Scattered through the text are 85 maps and diagrams, most of them pen-and-ink sketches showing morphological features, natural and cultural, of the various port cities. These are invaluable in clarifying the textual details and are one of the high lights of the monograph. There are also 56 half-tone illustrations and six folded maps.

Throughout Part 1 emphasis is placed on the intimate association of Japan's his-

tory and modern development with the sea. Most of her ancient cities and her modern ones as well have coastal locations. The insular nature of the country, its small land area, the scarcity of lowland fit for settlement, the concentration of population on littoral plains of aggradation—all these have been motives for turning to the sea for a living. The whole physical aspect of the archipelago emphasizes the importance of the coast line, or the zone of contact between land and water. Analysis is made of Japan's various forms of production and trade, and their relation to the sea is stressed. The final section of Part 1 describes the oceanic and climatic conditions, and the coastal forms of the several sections of the country as they affect the development of ports. General characteristics of the port landscapes are summarized.

In Part 2 over 50 ports are described in detail. Not only the commerce and trade of each of these coastal gateways are discussed, but also its hinterland character, location, site, historical evolution, natural harbor, industries, and general port and city landscape.

GLENN T. TREWARTHA

JAPANESE STUDIES OF CRUSTAL MOVEMENTS

CHÛJI TSUBOI. **Investigation on the Deformation of the Earth's Crust Found by Precise Geodetic Means.** Maps, diagrs., ills. *Japanese Journ. of Astron. and Geophys.*, Vol. 10, 1933, pp. 93–248.

NAOMI MIYABE. **Blocks in the Earth's Crust and Their Movements.** Maps, diagrs. *Bull. Earthquake Research Institute*, Tokyo, Vol. 9, 1931, pp. 256–270 and 407–422; Vol. 11, 1933, pp. 639–692.

No nation can compare with the Japanese in the determination of the movements of the earth's crust both at the time of earthquakes and at times of comparative quiet. Four years ago Imamura brought together the results of the investigations into "Topographical Changes Accompanying Earthquakes or Volcanic Eruptions" (see the note "Quantitative Seismology in Japan," *Geogr. Rev.*, Vol. 21, 1931, pp. 494–495). Tsuboi has now extended the compilation and has classified the different types of movements.

The movements are divided into two groups: vertical movements, determined by precise leveling repeated at least three times over the same routes; and horizontal movements, determined by repeated triangulations. These observations reveal fairly continuous movements of the earth's crust, even when no earthquake has occurred in the region during the interval. Tsuboi's article contains too much material to review in full; we can only mention some of the more important results.

The Japanese have for some years supported the idea that the earth movements in their country consisted in the tilting of blocks. Tsuboi is fully convinced of this: "Thus in the first approximation, the land block is, as its name implies, nearly rigid and is solely subjected to tilting movements." He refers with approbation to the work of K. Sezawa, who shows that such block movements cannot take place unless the friction between the blocks is extremely small. But under these circumstances there would be no great earthquakes; moreover, the reviewer thinks that the interesting calculation Tsuboi makes of the dilatation, shear, rotation, etc. in the region of the great Kwanto earthquake of 1923 would not be applicable to rigid blocks. Geologists are well acquainted with tilted blocks, but their observations are concerned with the final product rather than with details of the process; some kind of plastic distortion seems necessary to permit the tilting.

When the surveys were repeated across an active fault, movements near the fault were similar to those that occurred on the San Andreas fault in California in 1906 (though both horizontal and vertical displacements occurred), namely opposite sides of the fault flung back in opposite directions. The repeated surveys brought

out some interesting facts—that slow movements occurred before and after great earthquakes and that those that followed the earthquake were in some cases in the same directions with, and in other cases in the opposite direction to, those that took place at the time of the earthquake.

The routes of precise leveling, especially the earlier ones, were largely determined by the general topography. They usually follow valleys or the coasts and therefore make many sharp changes in direction, which complicate the interpretation of the distribution of earth movements. Lines of levels at right angles to a fault and extending possibly ten kilometers on each side would give more definite information; but it is not always easy to determine beforehand where a new fault will be formed or an old one become active.

Miyabe's studies apply especially to the region surrounding Sagami Bay, particularly to the north and west. They are based on the movements of triangulation stations of the second and third order, of which there are nearly 500 in the region, in the interval 1892–1925. It will be remembered that the great Kwanto earthquake took place in 1923. Miyabe recognizes the difficulty of separating the sudden displacements at the time of the earthquake from the slow displacements of the preceding interval. He shows on a map his division of the region into 73 blocks, roughly 10 kilometers in horizontal dimensions, though a few of the blocks are smaller. On each block there are from four to six triangulation points whose measured displacements lead to the inferred movements of the block; these displacements may be as much as two or three meters. Miyabe calculates for each block the vertical and horizontal displacements of the block as a whole, the tilt, and the distortion. Where the horizontal displacements of two contiguous blocks, at right angles to their junction, are different, he assumes dilatation or contraction. His conception differs with Tsuboi's "nearly rigid" block "solely subjected to tilting movements." In his summary Miyabe writes: "The writer concludes that it is plausible to assume that the earth's crust in the Kwantô district consists of a large number of crustal blocks, having horizontal dimensions ranging from 10 to 1 km."

Though we may not always agree with the interpretation of the observations, we must be grateful for the valuable data on earth movements they bring to us in an easily available form.

HARRY FIELDING REID

THE REBUILDING OF TOKYO, 1923–1933

The Reconstruction of Tokyo. xx and 419 pp.; maps, diagrs., ills. Tokyo Municipal Office, 1933. 12 x 9 inches.

This impressive volume commemorates the remarkable work of designing and rebuilding within the short space of ten years a great city decimated by earthquake and fire (compare the note, "The Earthquake Problem in the Reconstruction of Tokyo and Yokohama," *Geogr. Rev.*, Vol. 19, 1929, pp. 334–335). The history of the undertaking is divided into three parts—the damage done and emergency relief measures, reconstruction plans, and the work of reconstruction. Appendixes give a seismometrical study of the Kwanto earthquake of September 1, 1923, and an account of the following conflagration. Numerous photographs picture conditions before and after destruction and after reconstruction. The scope of the work of reconstruction may be defined by a list of the maps in color accompanying Part 3: Land Readjustment; Zoning System of Tokyo; Roads; Bridges in Tokyo; Rivers and Canals; Parks in Tokyo City; Municipal Primary Schools; Tokyo Municipal Water Supply System; Sewerage Systems; Garbage Disposal Works; Public Sanitation Works of Tokyo Municipality; Social Works of Tokyo Municipality; Tokyo Municipal Markets; Tokyo Municipal Electric System; Fire Prevention Zones. There is also a map of Tokyo and environs [scale 1 : 48,000] showing public services of the

city. To mention two only of the accomplishments: nearly three hundred street bridges and more than a hundred primary schools were rebuilt, the old wooden structures being replaced by those of fire and earthquake-proof design. Here, indeed, is an intelligent "response of human behavior to seismic environment," as Professor Davis put it in exhorting southern California to a like procedure (The Long Beach Earthquake, *Geogr. Rev.*, Vol. 24, 1934, pp. 1–11).

Ptolemy's Geography

Joseph Fischer. **Claudii Ptŏlemaei Geographiae: Codex Urbinas Graecus 82.** 4 parts. (Codices e Vaticanis selecti, Vol. 19.) E. J. Brill, Lugduni Batavorum [Leiden], Otto Harrassowitz, Lipsiae [Leipzig], 1932. M. 760. 14 x 9½ inches (first 3 parts), 29 x 20 inches (4th part).

This magnificent work is divided into two main sections, each of which has two parts. The feature of permanent value in the work consists of a reproduction in very large format of the 27 maps of the Codex Urbinas Graecus 82, the 27 maps of the Codex Vaticanus Latinus 5698, and three maps of the Codex Urbinas Graecus 83 and a facsimile of the text of the "Geography" as contained in the Codex Urbinas Graecus 82. The second main feature is a volume of critical comment on the subject of Ptolemy's life and work and a facsimile reproduction of 83 Ptolemy maps from 53 manuscripts, of which 24 are Greek, 2 Arabian, and 57 Latin. This part, representing a summation of present knowledge regarding Ptolemy and his "Geography," has not the permanent value of the facsimile reproduction of the Codex Urbinas Graecus 82, for in its very nature it is a changing thing. However, Father Fischer's critical commentary is the greatest contribution yet made to the study of Ptolemy and his "Geography." Father Fischer's acquaintance with the numerous manuscript copies and printed editions of the "Geography," together with his many years of comparative study of these works, gives him an equipment possessed by no other scholar.

The volume of critical comment is divided into three books. The first book is in three chapters, of which the first is devoted to Ptolemy as an individual and as a man of letters. The second treats of Ptolemy as a geographer and astronomer—the author of the "Almagest," "Tetrabiblos," "Geography," and "Astronomical Hand Tables"—and the third deals with him as a cartographer and with the questions that have been raised concerning his maps. Father Fischer discusses the questions concerning the "Geography" under the following headings: (a) The transmission of the Greek Ptolemy maps; (b) Ptolemy and Agathodaemon; (c) The relationship of the world map of Agathodaemon to the text of the seventh book of the "Geography"; (d) The relationship of the maps of Ptolemy to the text of the eighth book; (e) The relationship of the maps of Ptolemy to the corresponding text of Books II-VII: (1) Might the maps of Ptolemy, especially those of the Urbinas Ptolemy, be drawn after the text of Ptolemy, particularly after the text of the Urbinas Ptolemy? (2) Might the maps of the Urbinas Ptolemy or the maps of the A-Redaction generally be the sole basis of the text? (3) What may be said for an independent transmission, on the one hand, of the text, and on the other hand, of the maps? (f) The relationship of the text of Book VIII to the text of Books II-VII; (g) The relationship of the province maps, contained in the Supplement, to the corresponding text of Books II-VIII; (h) Urbinas Graecus 82 and Vaticanus Graecus 191.

It has been pointed out that many of the earliest Greek manuscript copies of Ptolemy do not contain the maps commonly connected with the "Geography." Furthermore, several of the most important of the early Greek manuscripts contain the statement that Agathodaemon of Alexandria mapped the whole world on the basis of Ptolemy's eight books of geography. These facts raise the following questions: (1) Did Ptolemy himself provide maps to accompany his "Geography"? (2) If so,

do those maps now known in connection with his "Geography" represent his originals closely? (3) What connection did Agathodaemon have with the maps of Ptolemy's "Geography"?

Father Fischer's conclusions are: (1) Ptolemy's own statements make it necessary to suppose that he made maps to accompany his work. (2) The errors and faulty methods of Marinus of Tyre's work made a complete revision of it necessary. (3) The 64 small provincial maps in the B-Redaction correspond in detail with Ptolemy's statement in Book I, Chapter XIX, and also with the text of Books II-VII. (4) The 26 regional maps were provided by Ptolemy himself to accompany his "Geography." (5) These regional maps could not have been constructed from the text alone because the maps contain details not found in the text and there are differences in the form of the names and in the positions assigned. (6) The text could not have been composed with only the maps we have as a basis. (7) The world map alone is the work of Agathodaemon. (8) The Agathodaemon legend about mapping the whole world is contained at the end of a supplement in the Codex Urbinas Graecus 82: this supplement is not the work of Ptolemy. (9) Scholars, not recognizing the authorship of the supplement, have ascribed to Ptolemy what was not his and then have denied to him his authorship of the maps. (10) The marked difference between the text of Books II-VII and the text of Book VIII is caused by a difference in the author's viewpoint. Ptolemy wrote the first seven books as a geographer; he wrote the eighth book as an astronomer. He employed in one part of his "Geography" results obtained from the methods of the geographer; in the other part the results were obtained by the methods of the astronomer. Ptolemy did not attempt to reconcile the resulting differences—in fact there was no sure basis on which he could have attempted to do so.

The second book of the volume of critical commentary is divided into four chapters. The first chapter—devoted to information concerning the Ptolemy manuscripts with maps and their relationship—contains four excerpts from the work of Mercati. The second chapter is a survey of the known manuscripts of the "Geography." The third and fourth chapters respectively are devoted to a detailed description of the Greek manuscripts of the A-Redaction and the Latin manuscripts of the A-Redaction (the manuscripts of Ptolemy's "Geography" are classified as A-Redaction or B-Redaction—a division made by C. Müller in 1867—according as they contain 26 maps common to the well known printed editions or 64 province and satrapy maps and 4 general maps showing Europe, Africa, North Asia, and South Asia).

In this detailed description of the A-Redaction maps Father Fischer discusses with special attention the maps of the Codex Urbinas Graecus 82. He and Mercati believe that the Codex Urbinas Graecus 82 is copied from a prototype marked by certain peculiarities. The table of contents gives references to pages or columns in which the corresponding sections were dealt with in the prototype. Mercati considers this proof that the prototype was written in Egypt, where a similar numbering of columns is found in papyrus rolls written in the first centuries of the Christian era. This hypothesis is substantiated by the fact that the Egyptian names of months are given side by side with the Greek names. This closely relates the Codex Urbinas Graecus 82 to the earliest manuscripts dating back almost to Ptolemy. The Codex Urbinas Graecus 82 is itself deemed by experts to belong probably to the late twelfth or early thirteenth century.

The third and final book of the volume of critical commentary has for its purpose the tracing of the "Geography" down the centuries. It is to be regretted that Father Fischer did not expand this and trace the influence of the "Geography" on geographical thought through the centuries. What influence did Ptolemy exert on his own times? Apparently the Greeks and Romans much preferred the descriptive geographies of Strabo and Pliny, with their long dissertations on people and their descriptions of places. Three centuries after Ptolemy's time a Christian

monk, Cosmas Indicopleustes, produced a book that is a negation of all of the science of Ptolemy. What is the story of the conflict of the views of Cosmas and other views of the early Church Fathers with the scientific geography of Ptolemy? Edrisi, the great Arabian geographer of the twelfth century, knew Ptolemy's "Geography." What influence did Ptolemy exert on the thought of Edrisi? Abulfeda located his cities by latitude and longitude. A comparative study of the latitudes and longitudes of recognizable places common to the geographies of Ptolemy and Abulfeda would be a significant comparison of the progress of scientific geography in eleven hundred years. Before the Greek manuscripts of Ptolemy's "Geography" were brought into Italy in about 1400, the Latin geographers had abandoned the concepts of geography of the early church. Whence came the influence that produced this change? Was it classical or was it contemporary Greek or Arabian influence? The "Imago mundi" shows that the predominating influence on Pierre d'Ailly's earlier work was Aristotle, Pliny, and Seneca rather than Ptolemy. Yet, before the time the Greek scholars brought the work of Ptolemy into Italy, Ptolemy had exerted some influence on the geographers of western Europe. The famous Catalan map of 1375 says: "The circumference of the earth is one hundred and eighty thousand stadia, that is to say 20,052 miles." This is the Ptolemy measure of the size of the earth. Whence came this fact to control the thought of the Catalan map maker?

When the geographers and discoverers of the Renaissance began the expansion of the knowledge of geography from that of the little world known to Ptolemy into the comprehensive knowledge of the entire globe, Ptolemy exerted his greatest influence. When and by whom were the travels of Marco Polo, the geography of India of Pliny, and the geography of Ptolemy combined with the legends of the Middle Ages, the discoveries of the Norsemen, and the discoveries of the Portuguese to form the geography of Behaim? It is certain that Behaim was not the originator of the combination.

Father Fischer has done much to solve many of the questions connected with the authorship of the Ptolemy maps, and he has given us a most beautiful if very expensive reproduction of one of the oldest existing manuscripts of the text and maps of the A-Redaction—the Codex Urbinas Graecus 82.

GEORGE E. NUNN

THIRD EDITION OF "MAPS AND SURVEY"

ARTHUR R. HINKS. **Maps and Survey.** xiv and 283 pp.; maps, diagrs., ills., index. University Press, Cambridge; The Macmillan Company, New York, 3rd edit., 1933. $4.25. 8½ x 6 inches.

This indispensable work by the secretary of the Royal Geographical Society on the study of maps and the processes of survey has for the most part been rewritten in the third edition, as the subject has changed radically in the last decade. The admirable purpose of the book is to provide the student with "some explanatory introduction, unobscured by much detail, which shall exhibit the general nature of the operations, and the relations to one another of the various parts of the subject." It was a happy thought to include a brief chapter on the history of early maps as a preface to the 50-page chapter on the modern map. "Map" here refers essentially to the base map made in the field showing on medium scales such concrete facts as physical features, railroads, roads, and towns. The problems connected with general world maps and special-purpose maps showing statistical information and abstract ideas do not fall within the scope of the book. The following 58 pages are devoted to the terse description of published maps—British official maps, international maps, maps of Europe, other foreign maps, and charts and atlases. The reproductions in color used in the previous editions have been omitted. Mr. Hinks "judged

it no longer possible to give any idea of the range of modern maps from a few small specimens"; but this perhaps overlooks the stimulus and interest to be derived by the student from examples critically selected and analyzed in detail.

The rest of the book is devoted to survey operations. Exploratory survey is dealt with first and points out clearly the opportunities and limitations before the "single-handed" traveler, "whose main business is to get through the country." There follows a readable chapter on trigonometrical survey, and then one, which might profitably be expanded, on land settlement and property surveys. The chapter on geodetic survey concludes with a statement in which the author gives his reasons for considering mistaken the adoption by the International Union of Geodesy and Geophysics at Madrid in 1924 of the Hayford 1910 figure of the earth. This makes an absorbing little essay, though in it and some other instances Mr. Hinks makes a departure into the more technical aspects of the subject: other instances are the account of the basis of construction of the barometric tables (pp. 134–137) and the brief but excellent section on the theory of photographic rectification of air photographs distorted by tilt (pp. 257–258).

Photographic surveying is dealt with in a remarkably concise 20 pages. The opinion is expressed that the future undoubtedly lies with stereographic survey. A discussion of the differences of opinion in regard to the value of different types of photographic survey concludes: "Recent experience suggests that for extensive, systematic, rapid, and thoroughly organized surveys the future lies with the air photographs, but that we must not neglect the great value of ground stereo-survey in exploration, as in the Shaksgam, or in the study of special problems which may more particularly interest the geographer, such as the growth and movements of glaciers, the changes in deltas and screes, the characteristics of land-forms, the structure and the denudation of volcanoes, and many such matters."

The final chapter is on survey instruments, and, short as it is, it is the only account (as far as the reviewer knows) that gives a general description of all the important modern survey instruments developed since the War. It includes the new theodolites, prismatic astrolabes, geodetic pendulums, and stereoplotters.

The Mount Washington Weather Station

Robert S. Monahan. **Mount Washington Reoccupied.** xv and 270 pp.; maps, ills., index. Stephen Daye Press, Brattleboro, Vt., 1933. $2.50. 8 x 6 inches.

After occupying the top of Mt. Washington for seventeen consecutive winters the U. S. Signal Service, the forerunner of the present Weather Bureau, discontinued meteorological observations at the conclusion of the 1886–1887 season. Nearly half a century later, during which time the Weather Bureau gradually abandoned its mountain stations, in contrast with the greater development of those in Europe, four young men set out to maintain the only high-altitude station in the United States during the Second International Polar Year. With the financial aid and coöperation of the New Hampshire Academy of Science, Blue Hill Observatory, Massachusetts Institute of Technology, Mount Washington Summit Road Company, and numerous firms and individuals, the summit was successfully reoccupied during the winter of 1932–1933 and, it may be added, has been maintained to date (May, 1934).

In "Mount Washington Reoccupied" Robert S. Monahan relates in an interesting day-by-day journal the daily activities and experiences of the 1932–1933 season. Particularly outstanding of the weather phenomena is the frequency of high wind velocities. On at least 14 days during the six months November through April velocities greater than 100 miles an hour were recorded, the highest, 152 miles an hour, coming on April 5, 1933. It was necessary to use electrically heated anemometers to prevent stalling by the formation of rime and frost. The lowest recorded

temperature was −29° F., in combination with a wind that exceeded 100 miles an hour.

The party was in constant radio communication with the lowlands, and mail, supplies, and repairs were obtained at frequent intervals all winter by members of the summit party who would make descents or through the kindness of mountain lovers who made the ascent for sport. During the season no less than 363 ascents were made of the mountain exclusive of the round trips of the observers.

PHIL E. CHURCH

A MAP OF WORLD RAINFALL

WILHELM MEINARDUS. **Eine neue Niederschlagskarte der Erde.** Map, diagrs. *Petermanns Mitt.*, Vol. 80, 1934, pp. 1–4.

This is really the first map of world rainfall—for the oceans have never before been completely represented—and it is of the greatest importance. The familiar difficulties of ascertaining rainfall at sea have not prevented this from being a reasonably accurate picture of the broader facts, and for this picture thanks are largely due to Gerhard Schott.

Some interesting generalizations are now possible. The seas are much rainier than the lands, presumably because evaporation on the sea is three times as great as on shore—a figure half as large again as earlier estimates. The ten-degree zone just south of the equator is unique in having rather less rain on the sea than on the land, apparently because of the extension of the Humboldt Current aridity 50 degrees of longitude westward into the Pacific, a similar arid belt in the Atlantic being balanced by the strip of abundant and excessive rains in the Indian Ocean in these latitudes, the rainiest large region in the world. Some of the rainiest land surfaces in the world also lie in this belt.

The total mass of water that falls on the earth as rain is given as 122,520 cubic miles, of which 60,960 fall in the northern hemisphere and 61,560 in the southern hemisphere—a surprisingly even division. Forty-eight per cent of the total falls between 20° N. and 20° S., another 48 per cent between 20° and 60°, north and south, and only 4 per cent between 60° and the poles.

Meinardus' map also sheds new light on the rainfall over the lands. The puzzling dry regions of eastern Brazil and of northern Venezuela are now seen to be balanced dry spots on each side of the equator within a broad area of abundant rain (40–80 inches) and are parts of a less rainy zone extending southeasterly from Texas to Ceará between heavier rains to east and west. The very heavy rains of western Colombia are seen to be part of the world's rainiest zone, which reaches almost without interruption around the world. The less rainy (less than 80 inches) side of Central America is as manifestly a rain shadow behind the mountains as the eastern—the Yankee or Banana Coast—is a belt of excessive rainfall from the windward exposure to the trades. Central American culture finds the west side of the Isthmian region not merely drier, and therefore more livable, than the east but drier than the average of this zone of very heavy rain. The Gulf of Mexico and the Caribbean, like mid-Amazonian Brazil and interior North America, may be said to have "interior" rainfall.

The excessive rains of Alaska and Chile are to be regarded not only as orographical rains on windward mountain slopes but as intensifications of the heavy rains of a vast oceanic region beyond, just as, in the opposite sense, the aridities of Lower California and Peru belong to the sea and not to the land. In the Peruvian instance the dry area on the sea is ten times as large as that on the land, even including its extension into Patagonia.

"Oceanic" would be a good name for the 40 to 80-inch rainfall belt. A quarter of the eastern United States lies in it, as well as the Pacific coast from San Francisco

to Vancouver. It covers most of inhabited Brazil, much of Colombia, the Antilles, Venezuela, and the civilized side of Central America, also southern Chile. It prevails from Japan down through China to Malaysia and covers half of India. It fringes the higher, westerly parts of Europe. In the rainy tropics these oceanic rains penetrate far into the land interior and are apt to become excessive at the

FIG. 1—Rainfall of the western hemisphere, redrawn from Meinardus' map of world rainfall.

sea border. The seas often have more than 80 or even more than 120 inches of rain in these zones.

The "sufficient," continental rains, covering the remainder of the principal settled and civilized areas of the world, are distinctly in zones between the oceanic rains. This is very evident from Meinardus' map but impossible to make out on rainfall maps of land areas only.

The most interesting region in the world for its rainfall, now clearly revealed for the first time, is that of the Island Indies between Australia, Japan, and India, with about half the area on the sea showing excessive rain. From this area extensions of excessively heavy rain reach up the eastern side of the Bay of Bengal to Assam, to southern Japan by way of Formosa, eastward across the Pacific Ocean to Colombia, southeasterly to the Fiji Islands and Samoa, and westerly across the Indian Ocean to within 500 miles of the African coast. Within the area are large windward stretches of more than 120 inches of rainfall and small leeward strips with less than 80 inches among the greater islands. Its oceanic and continental fringes provide rain for Australia, India, Japan, and China. A large part of the earth's rain must fall in this area.

Supplementary figures are given by the author in "Die Areale der Niederschlagsstufen auf der Erde," *Petermanns Mitt.*, Vol. 80, 1934, pp. 141–143.

MARK JEFFERSON

Economic Geography of the Sugar Industry

C. J. Robertson. **World Sugar Production & Consumption: An Economic-Geographical Survey.** vii and 142 pp.; bibliogr., index. John Bale, Sons & Danielsson, Ltd., London, 1934. 5s. 7½ x 5 inches.

An excellent little volume by a member of the staff of the International Institute of Agriculture at Rome. Against the "geographical realities" are set the other realities—economic, sociological, political—to whose influence the sugar industry, dealing with a "semi-luxury" commodity, is peculiarly susceptible. For instance, "while in most countries the use of sugar, if even in small quantities only, has come to be regarded as a necessity, as indicated by the relative inelasticity of consumption, it still retains sufficient of the character of a luxury to be to a peculiar extent the subject of Government taxation for revenue purposes."

The greater part of the book is devoted to a regional discussion of production. A chapter on the refining industry contrasts conditions in the tropical and temperate zones and draws the conclusion that "the relatively small stimulus to the migration of the refining industry to the tropics and the great advantage possessed by the refineries of the temperate zone of location in the heart of what is at present the principal market make it probable that the latter will retain their predominance."

The factors affecting consumption are analyzed and the sugar-consuming countries classified as "high, medium and low." "While the countries with higher rates are roughly those with a relatively highly urbanized population, high standards of living and low rates of taxation of the commodity, the countries with lower rates of consumption are predominantly agrarian, with generally low standards of living and high rates of taxation. Dietetic habits appear to be also a factor of importance. Each country, in fact, has its individual complex of factors affecting consumption."

The author's conclusion as to the prospects of the industry, in which the potentialities of cane-sugar and beet-sugar production are compared, was also set forth in the article "Geographical Trends in Sugar Production" (*Geogr. Rev.*, Vol. 22, 1932, pp. 120–130).

Survey of the World Economic Crisis

World Economic Survey, 1931–32. 327 pp.; maps, diagrs., index. *League of Nations Publs., Economic and Financial, 1932.II.A.18.* Economic Intelligence Service, Geneva, 1932. $2.50. 9½ x 6½ inches.

This survey of world economic developments in 1931–1932 is the work of Professor J. B. Condliffe, done at the instance of the Assembly of the League of Nations as an annual report and based mainly on data collected by the League's Economic Intelligence Service. It is a sequel to the report on "The Course and Phases of the World Economic Depression" prepared in 1930–1931 under the direction of Professor Bertil Ohlin.

The survey presents the background and development of the world economic crisis and covers all its more important aspects, including the disorganization of production, the depression in agriculture, and the decline in industrial output. It analyzes the collapse of prices in 1929–1930 in relation to the world's monetary mechanism and to international economic organization and governmental policies. The changing character of international trade, the balance of international payments, the movements of capital, the concentration of gold reserves, banking, credit, and the struggle for liquidity are considered in their bearing upon the world depression. The problems of unemployment are presented, together with wages and standards of living. The increased burdens of public debt, the strain on public finances, budgetary instability, and the growth of economic nationalism are analyzed and appraised. The depression is viewed from every angle and discussed as a world phenomenon.

Although the study is dated, the material is still pertinent, and much of it becomes more significant in the light of subsequent developments. Emphasis is placed upon a world point of view, and the principal contribution of the survey lies in making that viewpoint possible. Use is made of world statistics, but with full comprehension of their limitations, and, while the material available is preponderantly European and American, Professor Condliffe has been able to balance the discussion in important considerations with a personal knowledge of conditions in the Orient.

"World Economic Survey" is not geographic in its content or in its method of treatment, but in bringing together and interpreting this mass of material from many sources Professor Condliffe has performed a service for the geographer interested in economic conditions. The report, as a matter of fact, is perhaps of greater value to the geographer than it is to the economist, who is himself qualified to assemble and evaluate the data.

JOHN E. ORCHARD

ATLAS OF SILESIA

WALTER GEISLER, edit. **Wirtschafts- und verkehrsgeographischer Atlas von Schlesien.** Maps, diagrs. Text as supplement, vi and 29 pp. M. & H. Marcus, Breslau, 1932. RM. 50. 40 x 28 cm.

This atlas of Silesia should interest American geographers for three different reasons. For anyone studying any aspect of the regional geography of Silesia it provides an indispensable mine of information presented in the form of most value to geographers, that is on detailed but legible maps. Editors of regional atlases, which are greatly needed in this country, will be interested in the selection and arrangement of the maps. And, finally, certain of the maps furnish definite and valuable contributions to both the science and the art of cartography.

The atlas comprises 50 large sheets, 33 x 52 centimeters, containing 165 maps, cartograms, and diagrams, together with explanatory text. Thirty of the maps are full size on the scale of 1 : 750,000. Among the maps to which particular attention is called is that of economic areas, on which ten different types of landscape are distinguished: three mountain and hill types, six cultivated or forested plain types, which cover most of the area, and one urban or industrial type.

Of special interest is the statistical technique used in most of the agricultural maps and in that of population density. It was found that maps based on counties (*Kreise*) obscured many significant features known to exist. The use of the next smaller unit, communities (*Gemeinden*), resulted in maps too detailed to print—so detailed, in fact, as to hide rather than reveal significant features when mapped on a color basis. In place, then, of the 56 counties, 100 economic districts were mapped out on the basis of known natural and cultural features. The statistics for each district were then calculated from the original, unpublished, statistics from the 4600 odd communities—a prodigiously time-consuming task but one of unquestionable value. For instance, on such maps it is possible to bring out the real character of such narrow districts as the flood plain of the Oder as contrasted with the neighboring upland plain—a contrast quite lost on the county map. It would be interesting, however, to know whether the isopleth method, applied directly to community statistics, would not produce the same results, perhaps with less statistical labor.

Likewise original are the presentation of passenger-rail movement by directions and stations out from the main railroad termini and the mapping of mineral deposits that differentiates carefully the degrees of importance of present or potential use. More interesting to the reviewer were the maps of surplus and deficit production of the bread grains and of potatoes, and particularly the map of "relief energy," a means of showing relative relief that seems to have had its origin in a map by

Partsch in his "Schlesien" (see W. L. G. Joerg: The Development of Polish Cartography Since the World War, *Geogr. Rev.*, Vol. 23, 1933, pp. 122–129; reference in footnote 10).

In his introduction the editor indicates that as a resident of Silesia he was motivated constantly by the economic difficulties from which the region has suffered since the political changes resulting from the War. He is therefore all the more to be praised not only for the moderation with which those difficulties are mentioned in the text but particularly for the absence of any tendentious element in the maps: the severest critic could not object to more than one or two distinctly minor maps. The effectiveness of the maps in portraying the difficult conditions referred to is thereby made stronger. Both editor and printer are to be congratulated on the workmanship of the maps, particularly on their legibility and on the logical and pleasing choice of colors.

RICHARD HARTSHORNE

THE "ECUMENE" ON MAPS

ALFRED SÖDERLUND, edit. **Folkskolans Kartbok,** utförd av Generalstabens Litografiska Anstalt. 32 pp. of maps. P. A. Norstedt & Söners Förlag (Svenska Bokförlaget), Stockholm, 1933. Kr. 1.15. 10 x 7 inches.

This Swedish school atlas has 32 pages of maps in an aerial view planned to show "landscapes" as they would appear as far as areal coloring is concerned. For the rest, they are maps on a network of meridians and parallels, not pictures.

The most important tint is a lemon yellow, meant for tilled earth. This indicates the actual distribution of the people inhabiting the earth—where they live and work. Towns and cities are indicated and the larger ones are named, the selection of names being made with unusual restraint. Towns, of course, fall mostly in or close to the yellow tints. This amounts then to a density-of-population map worked into the map of the country. It appears to the reviewer to be the most important advance yet made in maps for teaching. No one can fail to perceive that the Canadians do not live about Hudson Bay, nor the Scottish people in the northern Highlands, nor the Argentines in Patagonia. This localizing of the habitat is made easier for the eye by the use of white for waste lands and green for forests. One must see the maps to realize how effectively they convey this idea of the human habitat.

There are minor imperfections of execution, of course. Lemon yellow is a faint color, yet on the map of South America, for instance, Paraguay should not be wholly deprived of tilled land. Generalization for a scale of 1 : 50,000,000 cannot escape exaggeration. The best results are in Western Europe (1 : 7,500,000) and Scandinavia (1 : 2,500,000). Switzerland does not seem fairly treated: the central plateau, between Zurich and Lausanne, has too much white.

There is also the traditional blue for ocean, a vermilion red for cities, an olive green for savanas on the Orinoco and in much of intertropical Africa (why not in much of Brazil too?). Enough relief is shown to make an adequate background for human geography: for physiographic or geologic use it would not suffice, nor was it meant to.

The colors are pleasing. The maps of Central and Western Europe are beautiful, and those of Scandinavia, naturally, are the gems of the book. The restraint in the selection of place names and of detail in the intricate coast line contributes greatly to clarity. Alfred Söderlund, the editor-in-chief, must be congratulated. He has an article on the plan of the maps in *Globen* for September, 1933.

MARK JEFFERSON